User's Manual

Version 1.7

SILMA®
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Using this Manual

The following sections describe conventions which have been used in this manual to denote specific concepts.

Windows

Windows that are part of the display are indicated in *Italics*. Examples: *Quick Pick Window* and *Graphics Window*.

The Top Bar

Pulldown menus from the top bar are indicated with bold letters in **This Typeface**. Example: **File** is a pulldown menu.

Panels

Panels are indicated with This Typeface. Example: Move Object is the title of the panel that is displayed when you choose *Move Object…* from the **Layout** pulldown menu.

Pulldown Selections and Commands

Selections from the pulldown menus, commands and command buttons are indicated with *Italics in this Typeface*. Examples: *Empty Cell* is a selection from the **File** pulldown menu, *Apply* is a command button.

Toggle Choices

Toggle choices are shown with a ◆ symbol in front of the label. Example: ◆ Checks is a toggle choice.

Switches

Switches are shown with a ❑ symbol in front of the label. Example: ❑ Show Reference Frame is the switch in Figure 1-17: Switch example on page 1-17.

Fields and Messages

The label and the information in the field are in this typeface. Example: Edge Length displays 1.0 in its field.

Messages, such as instructions and error messages that pop up or are displayed in the panels are quoted using this typeface. Example: Pick any edge of an object.

Filenames

`This typeface` is used for filenames. Example: **`default.sil`** is a file.

Keys

Keyboard keys are indicated by the "<>" symbols enclosing the key in capital letters in THIS TYPEFACE. Example: <RETURN> is a key.

Other Conventions

For the following, **this typeface** is used.

- booleans
- statements
- commands
- variables
- object names
- operators

Example: **menus();** is a command.

Chapter 1

Introduction to Soft Machines

Soft Machines® is a software simulator of NC machining processes using 3D graphics animation. The simulation is used for verification of post-processed machine code data. Soft Machines identify and eliminate NC program errors through execution of G and M codes on simulated machines, tools, parts and fixtures.

Soft Machines offers these features:

- ➢ Geometrical modelling of workcell components, including part geometry, cutting tools, fixtures, etc.
- ➢ Kinematics modelling of machine tools, which results in the simulated machines operating just like real machines. All types of machining equipment can be simulated, including
  - ■ 3, 4 and 5 axis
  - ■ Multiple turrets and spindles
  - ■ Tool changers, rotary tables and other auxiliary equipment
- ➢ Capability to load, interpret and execute NC part programs by the simulated machine tool
- ➢ Automatic collision detection of all moving machine parts with CAD models of machining stock, finished parts, tools and fixturing
- ➢ Reporting of simulation results, including error log reporting
- ➢ Batch mode or interactive simulation
- ➢ Support for custom G and M codes and canned cycles
- ➢ Support for individual machine controllers
- ➢ Cycle time and machining cost estimation

Soft Machines provides you with a single system for Computer Simulated Manufacturing applications, and the use of computer simulation to verify the manufacture, assembly, and test of parts and products. The simulated machine tool validates machine speed, tool changer routines, feed rates, interactions between machine components, and potential collisions. You can use Soft Machines to simulate entire manufacturing processes from start to finish. Soft Machines verifies machine code data in simulation, eliminating the need for dry runs with the physical machine.

Figure 1-1 illustrates how Soft Machines operates like the real machine tool on the shop floor.

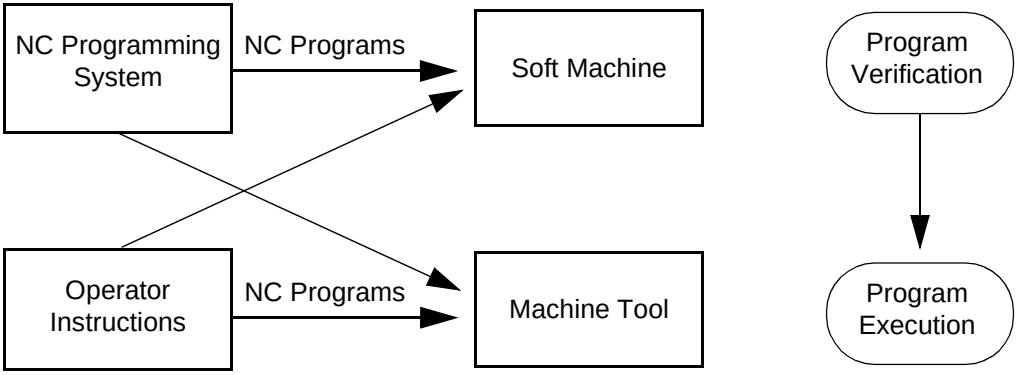
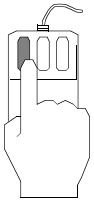


Figure 1-1 How Soft Machines works

Using the Mouse



In Soft Machines, the left mouse button is used most of the time. There are some special cases where all three buttons are used. These are described in the appropriate sections.

The Soft Machines Display

Each of the features displayed when you are using Soft Machines is described in the following sections.

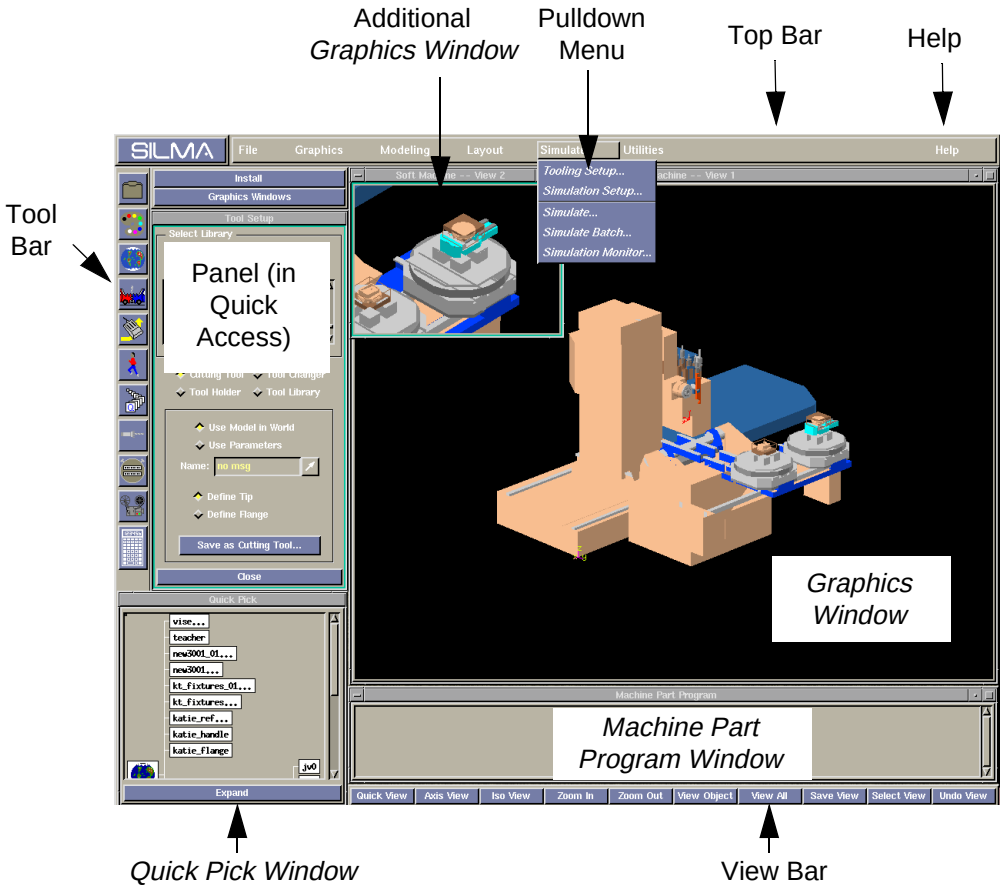
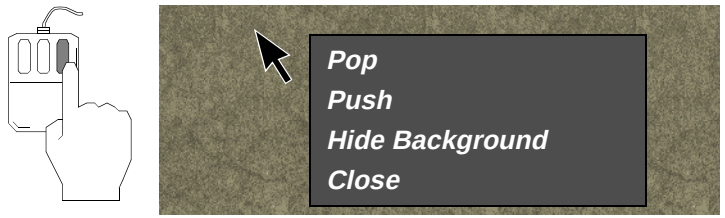


Figure 1-2 The Soft Machines display

NOTE	The *windows* can be resized by holding down the left mouse button on any side or corner and dragging to the desired size, then releasing the button.

Holding down the right mouse button with the cursor over the background displays these options:



Pop	Brings Soft Machines forward to the top layer of the desktop of your workstation.
Push	Pushes Soft Machines to the bottom layer of the desktop of your workstation.
Hide Background	Removes the background for ease in using other items on your desktop (such as shells) without closing Soft Machines.
Close	Makes Soft Machines an icon. Double-click on the icon with the left mouse button to re-open Soft Machines.

Graphics Window

The *Graphics Window* displays all graphic elements of a Soft Machines session.

The graphics display is represented in 3D. Wireframe display is available on all workstations with options for backface elimination, perspective and orthographic viewing. In all cases, surface information of the workcell model is used.

The Soft Machines graphics system is called the Virtual Graphics Processor (VGP). The VGP is self-allocating (virtual) and allows for a number of graphics capabilities: flat and Gouraud shading of polygons, ambient light, and full 24-bit color.

NOTE	For information on changing the graphics display, such as adding additional *Graphics Windows*, see Chapter 4, “Graphics Display Options”.

Quick Pick Window

The *Quick Pick Window* is located at the bottom left of your screen and contains a scrolling tree of the objects installed in your workcell. The *Quick Pick Window* provides an alternative to selecting objects from the *Graphics Window*.

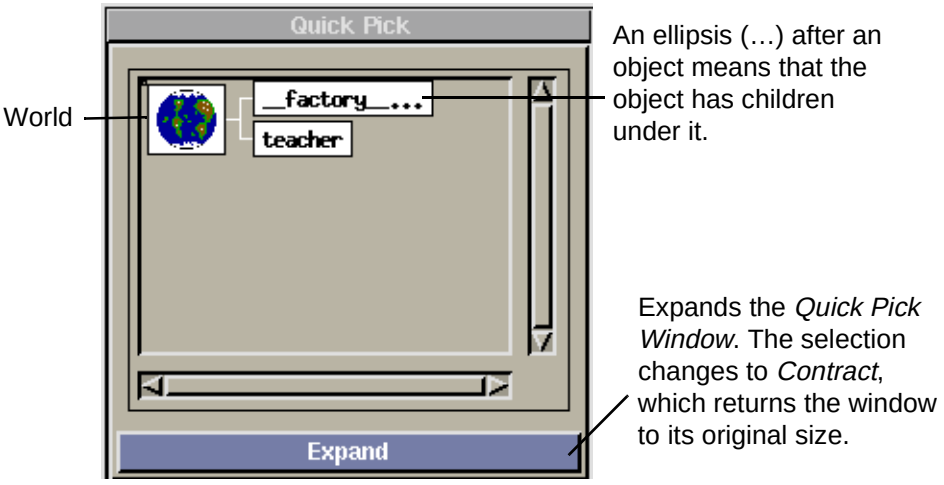

Quick Pick
World
__factory__...
teacher
An ellipsis (…) after an object means that the object has children under it.
Expands the *Quick Pick Window*. The selection changes to *Contract*, which returns the window to its original size.
Expand

Figure 1-3 The *Quick Pick Window*

The objects in the *Quick Pick Window* are shown in a tree structure. When an object is composed of other objects (or children), the parent object is shown with branches to the children.

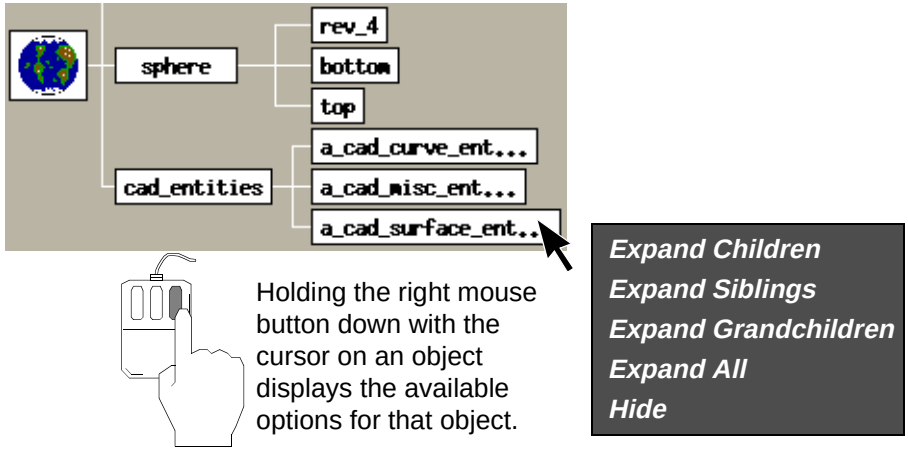


Figure 1-4 Using the *Quick Pick Window*

The selections in the pulldown menu displayed when you hold down the right mouse button change depending on the current status of the object. If an object has an ellipsis (…) after it, *Expand Children* will be one of the selections. If all the children are displayed, *Hide Children* will be one of the selections. These are the possible selections:

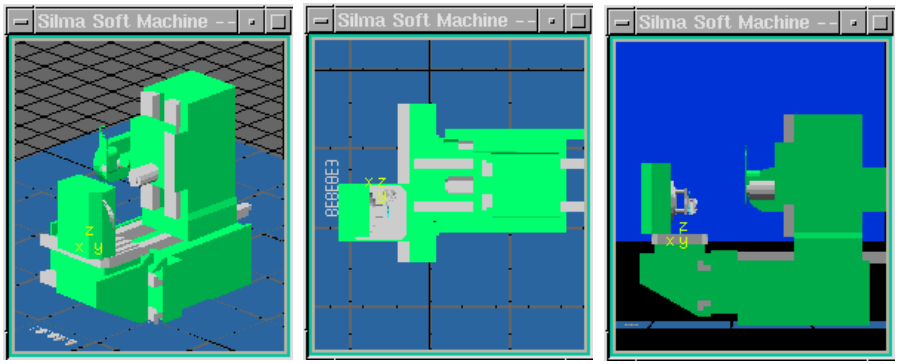
Expand Children	Shows all the children of the selected object.
Expand Siblings	Shows all children of the selected object's parent.
Expand Grandchildren	Shows all children and grandchildren of the selected object.
Expand All	Shows all objects in the World.
Hide	Hides the object the cursor is on.
Hide Children	Hides the object's children. An ellipsis (…) is put after the name of the parent object.

Expand is used to expand the *Quick Pick Window*. Depending on which other panels are displayed, the objects in the *Quick Pick Window* may be color-coded and a legend added which explains the color coding. For example, toggling ◆ Adopt in the Edit World panel displays a legend with parent and children objects color coded.

The View Bar

The view bar is located immediately below the *Graphics Window* and contains selections for changing the view of the perspective of the workcell, zooming in and out, and saving views of the workcell.

The camera angle concept of the view bar enables you to see the object from different angles similar to the way a camera moves around an object—the object itself does not move.



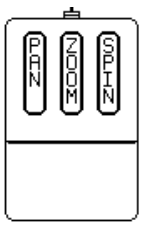
Isometric View Top View Side View

Figure 1-5 Different views

The following sections describe the view bar selections.

Quick View

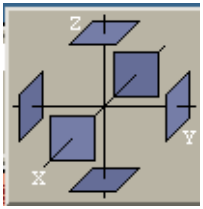
Enables you to scale, pan, or rotate the view by using the mouse buttons.



After you click on *Quick View*, the left button pans, the middle button zooms and the right button spins.

Axis View

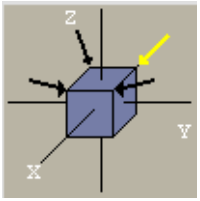
Looks along an axis towards the origin.



As you move the mouse with the left button held down, each of these views is highlighted. Releasing the mouse button with a view highlighted selects that view.

Iso View

Shows an isometric view of the workcell.



As you move the mouse with the left button held down, each of these views is highlighted. Releasing the mouse button with a view highlighted selects that view.

Zoom In

Enables you to select an area of the screen for viewing.

To use *Zoom In*:

1. Move the cursor to the upper left corner of the desired viewing area in the *Graphics Window*.
2. Hold down the left mouse button.
3. Drag the cursor to select the lower right corner of the desired viewing area.
4. Release the left mouse button. The selected area in the *Graphics Window* will be enlarged to the size you select.

Zoom Out

Enables you to zoom out to see more of the workcell.

To use *Zoom Out*:

1. Move the cursor to the upper left corner of the desired viewing area in the *Graphics Window*.
2. Hold down the left mouse button.
3. Drag the cursor to select the lower right corner of the desired viewing area. When you drag the cursor towards the center of the *Graphics Window*, the frame will get smaller.
4. Release the left mouse button. The selected area in the *Graphics Window* will shrink to the size you select.

NOTE Using PAN from the *Quick View* works well in conjunction with *Zoom In* and *Zoom Out* by helping to keep the image in the center of the *Graphics Window*.

Point

Clicking *Point* then clicking on a workcell object in the *Graphics Window* changes the view such that the location where you clicked is in the center of the *Graphics Window.*

View Obj

Enables you to select a workcell object to view, either by clicking on it with the left mouse button, or by making a selection from the *Quick Pick Window*. The object is shown as a *Zoom In* view in the *Graphics Window*. Resizing the *Graphics Window* will resize the object, so you continue to have a complete view of the object.

View All

Optimizes the view to include all visible objects in the workcell. Resizing the *Graphics Window* will resize the objects, so you continue to have a complete view of all visible objects.

Save View

Displays the View Name field. Entering a name and pressing <RETURN> or clicking the return button saves the workcell view.

Select View

Displays the Select View panel, from which you can select a saved workcell view.

Undo View

Undoes the most recent view bar command.

Machine Part Program Window

The *Machine Part Program Window* displays NC part programs (G code) during simulation. Part program statements scroll through the *Machine Part Program Window* as program statements are being executed. During simulation, error messages are displayed in this window.

The Top Bar

The top bar is located at the top of the screen, and contains a list of the available pulldown menus. The pulldown menus in the top bar provide access to the panels.

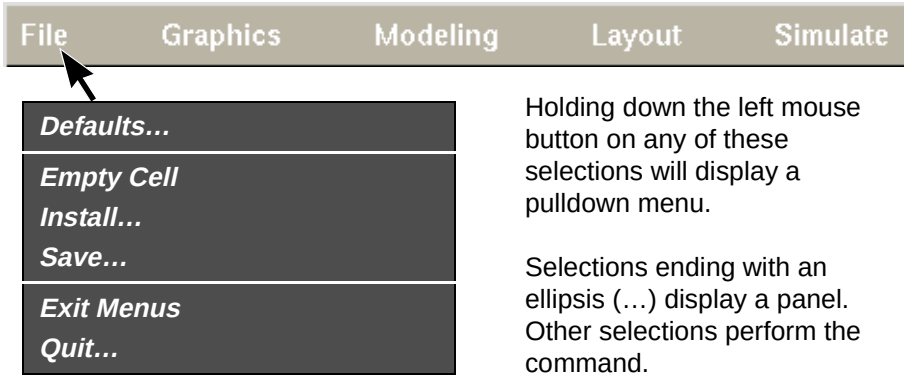


Figure 1-6 The top bar

To make a selection you can either

- Drag the mouse (with the left button held down) until the desired selection is highlighted, then release the button.
- Click on a selection on the top bar to display its pulldown menu, then click on your selection.

Using Help

A *Help Window* is available for each panel, which provides information about using that panel.

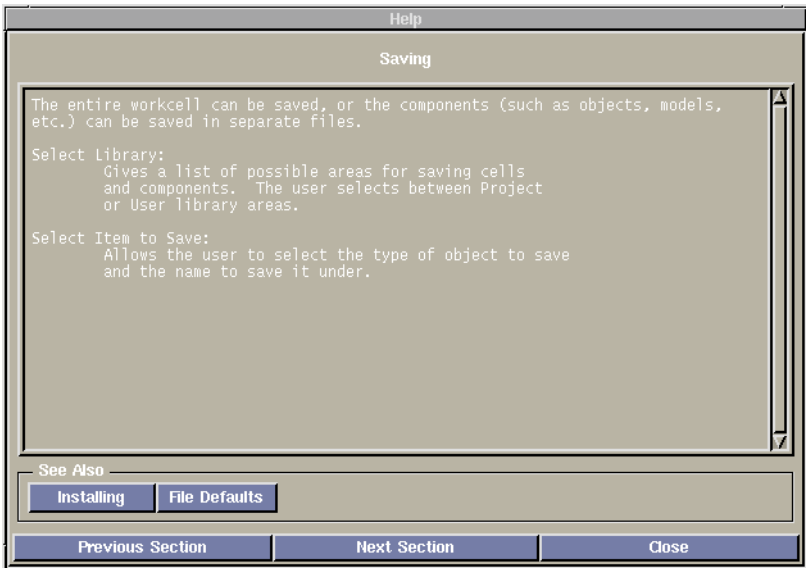

Help
Saving
The entire workcell can be saved, or the components (such as objects, models, etc.) can be saved in separate files.
Select Library:
Gives a list of possible areas for saving cells and components. The user selects between Project or User library areas.
Select Item to Save:
Allows the user to select the type of object to save and the name to save it under.
See Also
Installing
File Defaults
Previous Section
Next Section
Close

Figure 1-7 A *Help Window*

The See Also box contains command buttons for displaying information about related topics.

Previous Section and *Next Section* display the selected and related topics.

You can access on-line help in two ways:

- Selecting *Table of Contents...* from the **Help** pulldown menu displays the available topics. Click on a topic to display information about it.
- Move the cursor onto a panel. Press the <Help> key on your keyboard. The Help panel pops up displaying information about that panel.

NOTE	If your keyboard does not have a <Help> key, press the <F1> key.

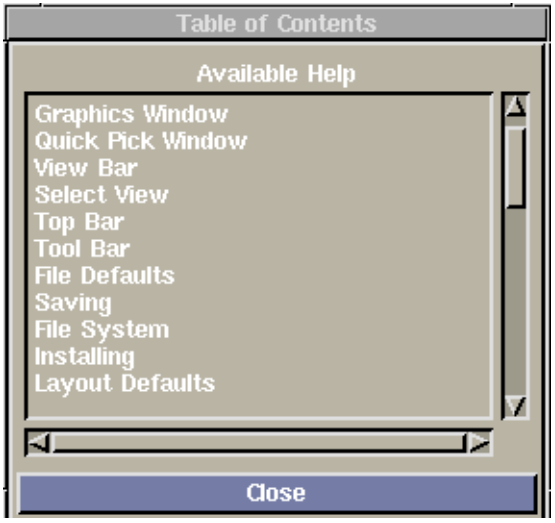


Figure 1-8 The *Table of Contents Window*

Panels

Choosing a menu selection that ends with an ellipsis (…) or clicking a tool bar button displays a panel. These panels can contain a variety of selections in the form of command buttons, editable and display fields, toggle choices, and switches.

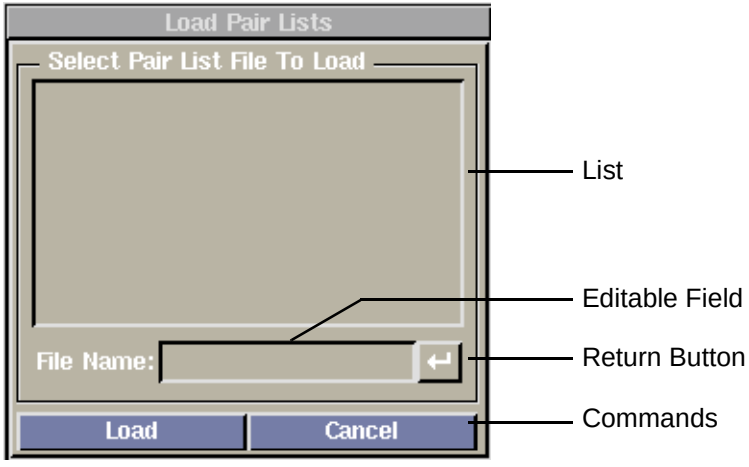


Figure 1-9 Panel example

The types of items that are in the panels are described in the following sections.

Command Buttons

Commands are performed either by making a selection from a pulldown menu, or by clicking on a command button in a panel. Command buttons are the blue boxes with the white labels. A command button or pulldown menu selection with an ellipsis (…) displays another panel.

There are several common command buttons:

OK	Performs the action and dismisses the panel.
Apply	Performs the action or applies settings. The panel is still displayed so additional actions may be performed.
Close	Dismisses the panel.
Cancel	Dismisses the panel without applying the settings. Actions already performed are not undone.

Toggle Choices

Panel items that have diamonds next to them indicate that you must choose only one of these at a time. Example: you must choose Affix/Unaffix or Rename or Adopt or Delete.

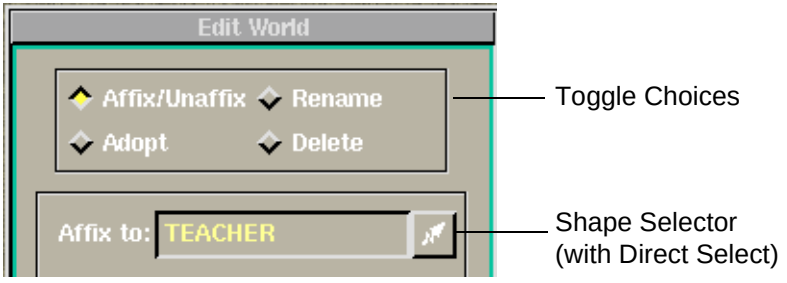


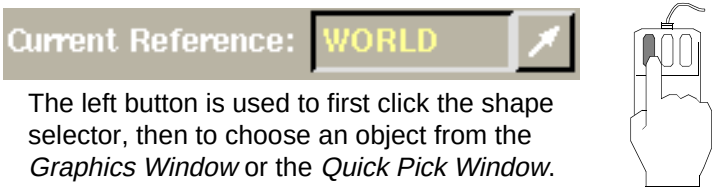
Figure 1-10 Toggle choices and shape selector

Shape Selectors

Shape selectors enable you to select objects from the *Graphics Window* or the *Quick Pick Window*. Depending on the kind of shape selector, you can select one object or multiple objects.

When you click any shape selector using the left mouse button, a pop up box instructs you to make a selection or click *Cancel Selection* in the box.

After clicking the shape selector, clicking on an object in the *Graphics Window* or the *Quick Pick Window* using the left mouse button selects the object. The name of the selected object replaces the text displayed in the field.

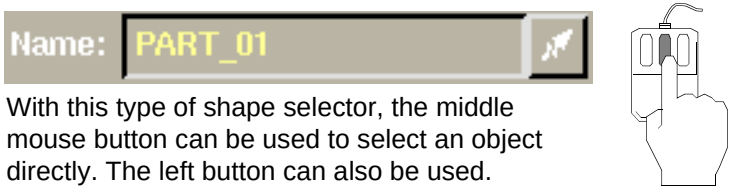


The left button is used to first click the shape selector, then to choose an object from the *Graphics Window* or the *Quick Pick Window*.

Figure 1-11 Single object shape selector

For complex objects where the components are not clearly seen, an option is available that makes selecting the component from the *Graphics Window* easier. If you hold down the left mouse button on an object in the *Graphics Window*, a pop up box lists not only the object, but all the components (children) of that object. Select the appropriate shape with the left mouse button.

Shape selectors can also have a “direct select” option, meaning that selecting an object using the middle mouse button gives you the same result as first clicking the shape selector with the left button.



With this type of shape selector, the middle mouse button can be used to select an object directly. The left button can also be used.

Figure 1-12 Direct-select, single object shape selector

Shape selectors can also have a multiple-selection option. These selectors can be used to select single objects, as described above, or to select more than one object.

Figure 1-13 Multiple object shape selector

If you would like to select more than one object, you need to hold down <SHIFT> while selecting the objects in the *Graphics Window* or the *Quick Pick Window*. After selecting the first object, a pop up box will be displayed.

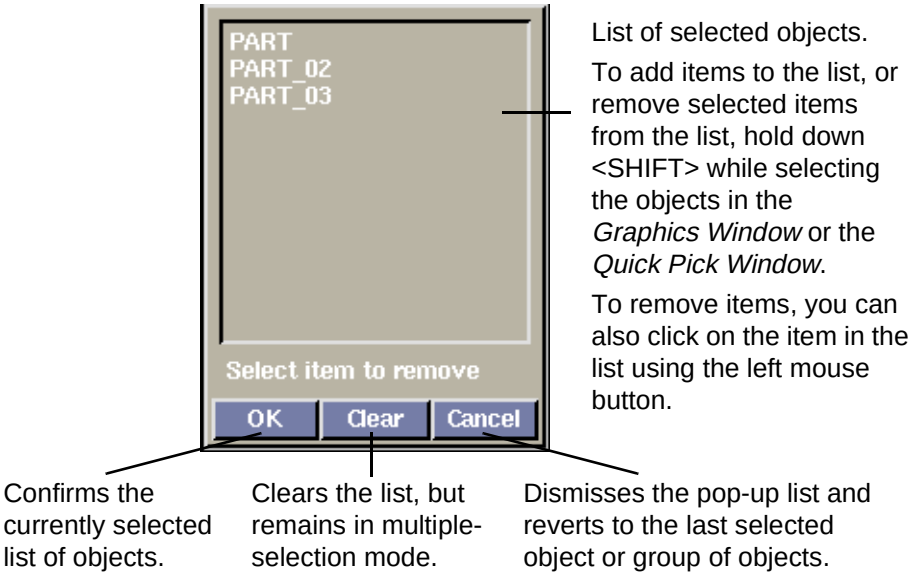

PART
PART_02
PART_03
Select item to remove
OK
Clear
Cancel
List of selected objects.
To add items to the list, or remove selected items from the list, hold down <SHIFT> while selecting the objects in the *Graphics Window* or the *Quick Pick Window*.
To remove items, you can also click on the item in the list using the left mouse button.
Confirms the currently selected list of objects.
Clears the list, but remains in multiple-selection mode.
Dismisses the pop-up list and reverts to the last selected object or group of objects.

Figure 1-14 Multiple selection pop up box

During the selection process, all current selections will be highlighted in the *Graphics Window* and the *Quick Pick Window*. Your previous selections will remain highlighted until you have confirmed your new selection.

To confirm a multiple selection, click *OK* in the pop up list.

NOTE	You can also confirm your multiple selection by clicking on one of the selected shapes without holding down <SHIFT>.

Graphics Selectors

Clicking on a graphics selector with the left mouse button enables you to pick an item from the *Graphics Window*, or from a pop up list.

Figure 1-15 Graphics selector example

NOTE When using a graphics selector, you cannot make a selection from the *Quick Pick Window*.

Editable and Display Fields

Both editable and display fields have a label ending with colon (:) next to them. The information in an editable field is displayed in yellow. An editable field can be changed by entering new information and then clicking the return button, pressing <RETURN>, or clicking *OK* or *Apply* (if the panel has these selections). Double clicking on the value in an editable field will highlight it and replace it with the value you enter.

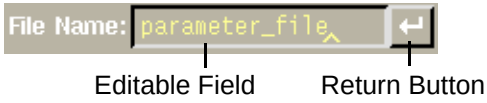


Figure 1-16 Editable field

If the information in the field is displayed in white, this is a display field and cannot be edited.

Switches

Panel items that have a box next to them are switches. Click in the box to turn that option on. The box will appear yellow if on. Example: ❑ Show Reference Frame can be switched on or off.

Figure 1-17 Switch example

Choice Buttons

Choice buttons display a pulldown menu containing the available selections or settings.

In the example below, holding down the left mouse button on the Units choice button displays a pulldown menu. Make your selection the same way as you make top bar menu selections.

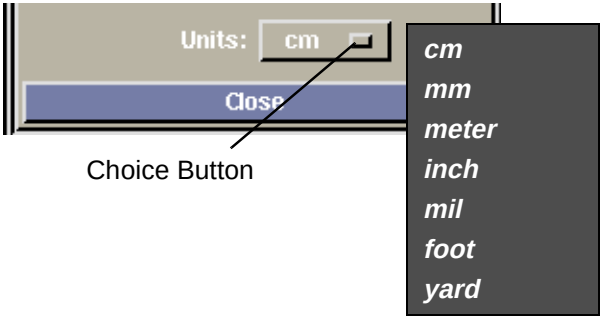


Figure 1-18 Choice button example

Sliders

Sliders are used to graphically change settings.

Move the cursor to the marker, hold the left button down and drag to the desired setting.

You can also click in the slider box in the space to the right or left of the marker.

Figure 1-19 Slider example

Lists

Lists are used to display lists of items, such as file names, that change.

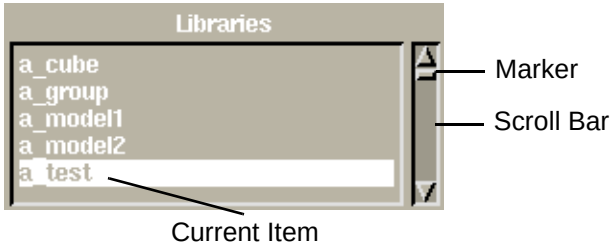


Figure 1-20 List example

Viewing the List

You can view different sections of the list by using the scroll bar at the right side of the list. Clicking the left mouse button on the arrows move up or down, as does clicking in the space above or below the marker. Dragging the marker with the left mouse button held down also scrolls the list. Scrolling down the list does not change which item is selected. To select an item from a list, you must click on it.

Selecting an Item from a Single-Selection List

Most of the lists are single-selection, meaning that only one item can be selected at a time. Clicking on an item with the left mouse button selects it. Clicking on a different item selects that item and "unselects" the previous selection.

Selecting Items from Multiple-Selection Lists

You can select more than one item from some of the lists by using the left mouse button and keyboard:

- To select more than one consecutive item:

  Move the cursor to the first item, hold down the left mouse button and drag the cursor until the range of items is selected.

You can also click on the first item in the range. Hold down the <SHIFT> key and click on the last item in the range (you can use the scroll bar, if necessary).

- To select more than one non-consecutive item:

  Select the first item or range of items. Hold down the <CONTROL> key and select another item or range of items.

- To “unselect” an item:

  Click on a selected item. The highlighting is removed from that item.

List Buttons

Clicking a list button displays the list of applicable items. Clicking on an item in the list with the left mouse button selects that item.

There are two types of list buttons: restricted and unrestricted. Unrestricted list buttons allow you to enter your selection directly into the field or choose an item from the list.

Restricted list buttons only allow you to choose an item from the list. The field displays the current selection.

If a *Search* selection is included, clicking on it enables you to enter a search string. Clicking anywhere on the list with the right mouse button dismisses the list. You also have the option of entering a name.

Figure 1-21 List buttons

Color Buttons

Color buttons are used to set the color for that field.

Figure 1-22 Color button

Clicking on a color button displays the Select Color panel.

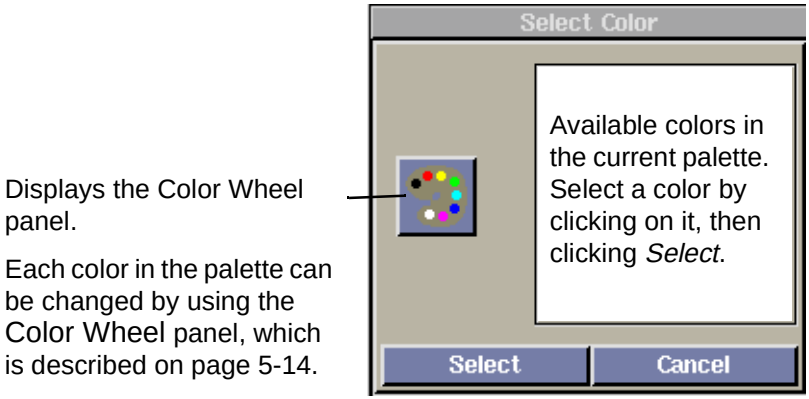

Displays the Color Wheel panel.
Each color in the palette can be changed by using the Color Wheel panel, which is described on page 5-14.
Select Color
Available colors in the current palette. Select a color by clicking on it, then clicking *Select*.
Select
Cancel

Figure 1-23 The Select Color panel

Selecting a color from the palette in the Select Color panel changes the color in the color button.

Increment Buttons

Holding down the left mouse button with the cursor on the increase button increases the value in the field by small increments. The decrease button decreases the value.

Figure 1-24 Increment buttons

The Tool Bar

You can display some of the most frequently used panels by clicking the appropriate button from the tool bar. Table 1-1 describes the tool bar buttons.

Button	Description	Button	Description
	Displays the Install panel.		Displays the Tool Setup panel.
	Displays the Appearance panel.		Displays the Simulation Monitor panel.
	Displays the Edit World panel.		Displays the Movies panel.
	Displays the Move Object panel.		Displays a calculator.
	Displays the Collision Detection panel.		Displays the Measure panel.
	Displays a machine pendant.		Quits the session.
	Displays the Batch Mode Simulate panel.		

Table 1-1 Tool bar buttons

Pop up Boxes

Pop up boxes are displayed when you make selections that have more than one way of accomplishing the task, to provide you with additional instructions, or to ask for a confirmation.

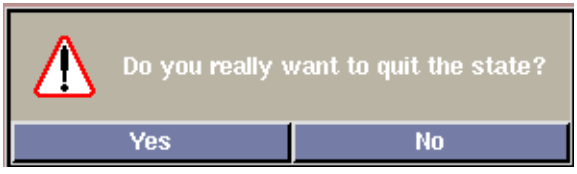


Figure 1-25 Pop up box example

Using the Quick Access

Most of the panels will pop up on the left side of the screen. They are in the Quick Access. If you display another panel, without closing a displayed panel in the Quick Access, the original panel is shown as a command button above the new panel. If you click on the command button, the original panel is displayed and the new panel is shown as a command button. This way, you can quickly access the panels you frequently use without having to display them from the top bar.

You can move the panels out of the Quick Access by holding the left mouse button down with the cursor on the title bar and dragging the panel. The panel will remain displayed until it is dismissed.

Libraries

In Soft Machines terminology, a **library** is a directory that stores data and information about Soft Machines entities (see Table 1-2). You can organize these libraries by project and access them using the panels.

Libraries generally reside under one of two directories:

`~cim/projects`	contains models, tools, cells, etc. that are specific to an individual project.
`~cim/users`	contains models, tools, cells, etc. that belong to each user.

The contents of libraries must have certain filename extensions to be recognized by Soft Machines. Using standard file extensions is also helpful for distinguishing among the contents of a particular library subdirectory. When you save cells and models with the *Save* commands in the menus and panels, Soft Machines generates the file extensions automatically.

Subdirectory	Extension	Description
models	.model	Models that were generated with Soft Machines or from a CAD system.
nc_tooling	.ct	Soft Machines cutting tool model.
	.th	Soft Machines tool adaptor/holder model.
	.tc	Soft Machines tool changer model.
	.tlib	Soft Machines tool library.
cells	.cell	Complete workcells with machines, fixtures, parts, tools, etc.
part_prog	.gc	G-code part programs (machine code data).
	.job	Simulation set up file for batch mode simulation.
	.bat_list	Batch mode simulation file.
	.err_log	Error log output from Soft Machines.
videos	.sgm	Graphical data of a movie.
	.cmd	Command data of a movie.
simulations	.play	First Cut (metal removal) playback files.
cad	.exp	Catia model files (output from catsilma).
	.igs	IGES data files.
	.stl	SLA data files.

Table 1-2 Libraries and filename extensions

The G-Code Language

Soft Machines verifies an NC machining process by uploading and executing NC part programs in a simulated workcell. These part programs contain machine code data in the ANSI/EIA RS274D standard format, commonly known as G-code. This is the format supported by most machine tool manufacturers and NC post-processors on CAD systems.

To simulate NC part programs, Soft Machines translates the part programs into equivalent commands and executes them to perform the simulation.

G-code commands are classified into three categories:

- Machine-independent generic commands
- Machine-dependent generic commands
- Machine-dependent specific commands (user commands)

Machine-Independent Generic Commands

These basic commands are understood by all NC machines and executed in a non-equivocal fashion. Examples are G-codes such as G00 (positioning), G01 (linear interpolation), G90 (absolute input), G91 (incremental input) and M codes such as M00 (program stop), M03 (spindle on, CW), and M08 (coolant on).

Machine-Dependent Generic Commands

These commands are understood by all NC machines but executed in a machine specific way. Examples are M06 (tool change), M10 (clamp). Each machine will have its own procedure, and time delay, for changing tool or clamping/unclamping fixtures.

Machine-Dependent Specific Commands (User Commands)

These commands are either unique commands to a particular machine tool, or are user-defined commands. Examples are canned cycles and user-defined sub-routines.

NOTE	Appendix C, “G & M Codes”, contains a representative list of the codes mentioned above.

The SIL Language

SIL (SILMA Interactive Language) is a general purpose, high-level language developed by SILMA. SIL syntax is essentially that of Pascal, but the semantics extend beyond Pascal to include advanced programming features typical of fourth-generation programming languages.

SIL serves as the language interface for developing Soft Machines programs. Soft Machines is written entirely in SIL.

SIL is well-suited for simulation and control applications; it is also a fully general object-oriented, concurrent programming language. SIL offers a combination of efficiency, flexibility, and approachability unique among the current generation of object-oriented programming languages.

A recent addition to SIL, the **device facility**, allows a closer approach to the ideal of software construction by plugging together standard components. Devices are particularly effective for user interface development, and for distributed computing (in which SIL devices participating in the same application reside on several networked computers).

For a detailed description of SIL and instructions on how to use it, see the *Soft Machines Developer’s Guide*, available from SILMA.

Geometry

To simulate three-dimensional space and its contents, we need a means of describing how the contents are situated in the region of space being simulated. This is called **spatial geometry** or simply, geometry.

With Soft Machines, geometric descriptions are used to construct and locate simulated objects. The Soft Machines software uses those same geometric descriptions to perform kinematic transformations on the simulated objects for moving them around the simulated space.

Geometric Terms

To simulate objects in a three-dimensional space, Soft Machines manipulates a data structure in which all simulated objects are represented by a type called **shape**.

To handle multiple shapes, Soft Machines arranges all shapes in the simulated world in a tree structure. The root of this tree is a special shape which lacks any associated geometry and is called **World**. This tree structure is seen in the *Quick Pick Window*.

Every shape (including World) has an associated local reference frame which is called its **pose**. The pose of the World is the master reference system, and every other shape in the World tree has a pose which is specified relative to the World pose. When you select a reference frame using the menus, the pose of some shape is always selected. The default reference frame is the pose of the World and may sometimes be called the **Universe coordinate system**.

The language used in this manual and when speaking about Soft Machines entities contains terms like **coordinate system**, **frame**, **pose**, and **reference system**. The following items explain the distinctions between these terms:

- All shapes have a pose.
- Frame shapes are a special kind of shape (which of course also possess a pose).

- Frame shapes are physical objects in the simulated world, and can usually be picked with the mouse like any other shape.
- Poses can be displayed, but are ephemeral—they cannot be picked.

Every point on an object has a fixed location relative to its pose. When you manipulate objects, you only need to be concerned with their poses.

Pose

A pose represents the reference frame of an object. In Soft Machines, it is described using six values that combine its position and orientation (**x**, **y**, **z**, **yaw**, **pitch**, **roll**).

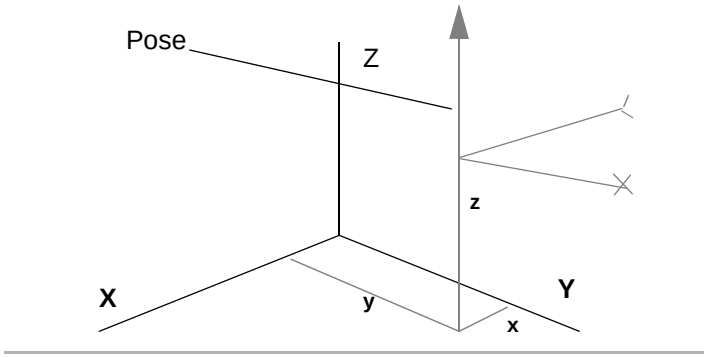


Figure 1-26 Pose

An example of a pose on the left-hand side is illustrated in Figure 1-28, “Pose (left-hand side)” on page 1-29. It is displayed with three orthogonal lines and the text letters x, y, and z, which are labels for the axes.

Frame

Soft Machines provides a special kind of shape called a **frame** which is used primarily for teaching desired positions of objects (e.g., via points in a path along which another shape will move). The geometry of a frame shape is shown on the right hand side of Figure

1-27—one axis looks like an X, one like a Y, and the Z axis looks like a pointer. Because a frame is also a kind of shape, it has a pose which lies coincidently with the frame's geometry.

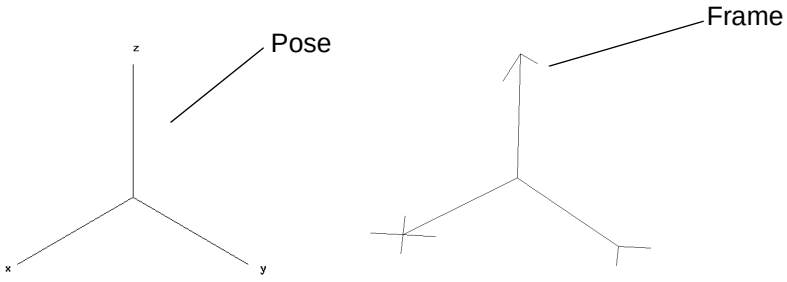


Figure 1-27 Coordinate frames

Position

A position specifies a point in space relative to the origin of some reference frame. The position of the point is at X, Y, Z in Cartesian coordinates. In Soft Machines, the units of position are specified by centimeters by default (but can be changed easily to the units of your choice).

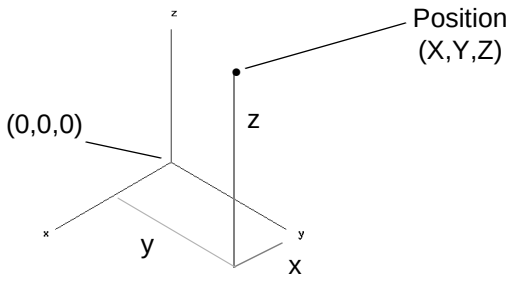


Figure 1-28 Pose (left-hand side)

Orientation

An **orientation** is the angular rotation of a set of axes relative to some reference frame. In Soft Machines, the angles of orientation are specified in degrees (**yaw**, **pitch**, **roll**). **Yaw** is a rotation about the X-axis, **pitch** is a rotation about the Y-axis, and **roll** is a rotation about the Z-axis.

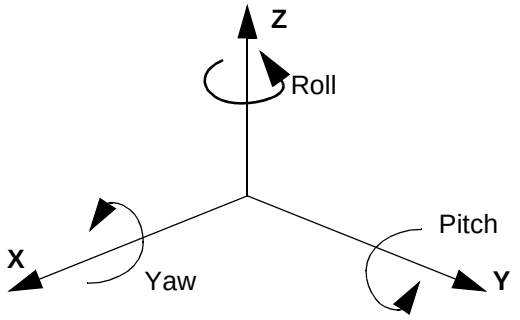


Figure 1-29 Orientations

To specify completely how an object is situated in space, you will need to describe both the position and orientation of its reference frame. For this reason, it is often convenient to specify position and orientation together as a pose. The pose of an object is the position and orientation of its reference with respect to some other reference.

NOTE	This section described terms you need to know to use Soft Machines. Instructions for manipulating geometry using the SIL language can be found in the *Soft Machines Developer's Guide*, available from SILMA.

Chapter 2

Getting Started

This chapter explains general procedures, such as saving your work and quitting Soft Machines.

Starting Soft Machines

The following steps explain how to start Soft Machines.

1. Enter **sspa** in a shell window. The Product Administration panel is displayed.

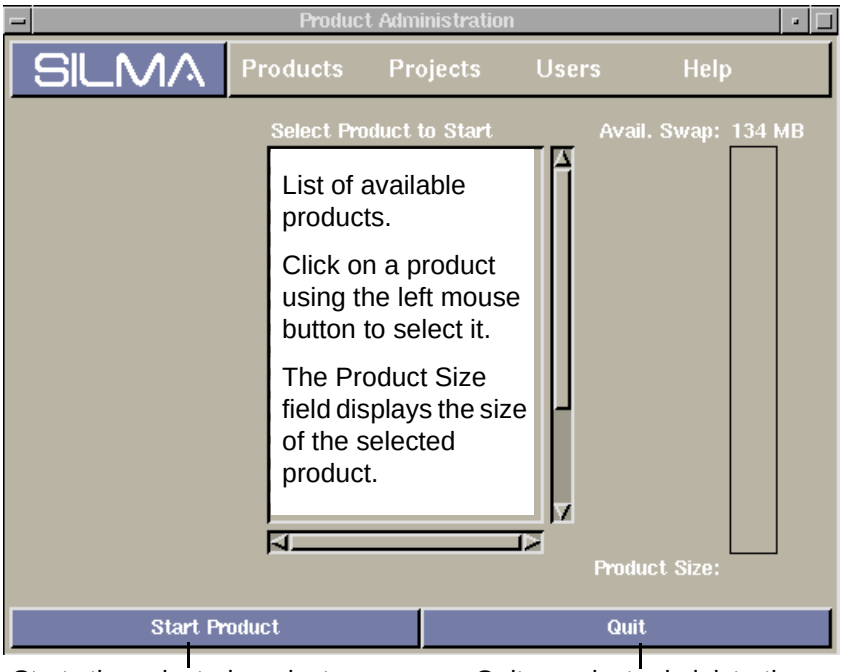


Figure 2-1 The Product Administration panel

NOTE For more information on working with this panel, see the *Installation Guide*.

2. Click on a Soft Machines product in the Select Product to Start list.
3. Click *Start Product*.

NOTE	Soft Machines should be started with access to the menus. If a SIL> prompt is displayed in the shell window, enter **`menus();`** to start the product.

Using the File Menu

The **File** menu is used for installing objects in the workcell, saving the workcell and objects in the workcell, and quitting Soft Machines.

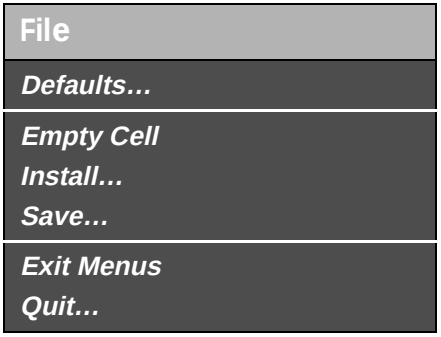


Figure 2-2 The **File** menu

Table 2-1 describes the selections available from the **File** menu.

Selection	Description
Defaults…	Displays the File Defaults panel. See “Backing up Automatically” on page 2-3.
Empty Cell	Creates a new workcell. If you have any objects in the workcell (or a previously-saved workcell installed), a confirmation requestor asks you to confirm that you want to remove everything that is currently in the workcell.
Install…	Displays the Install panel. See “Installing Workcell Objects” on page 5-2.

Table 2-1 **File** menu selections

Selection	Description
Save…	Displays panels for saving the workcell and workcell objects. See “Saving Your Work” on page 2-5.
Exit Menus	Disables the menus and displays the SIL> prompt in the shell window. You can activate the menus by entering **menus();** at the prompt.
Quit…	See “Quitting Soft Machines” on page 2-6.

Table 2-1 **File** menu selections (continued)

Backing up Automatically

The File Defaults panel is used to instruct Soft Machines to make periodic backups of your workcell. Selecting *Defaults…* from the **File** pulldown menu displays the File Defaults panel.

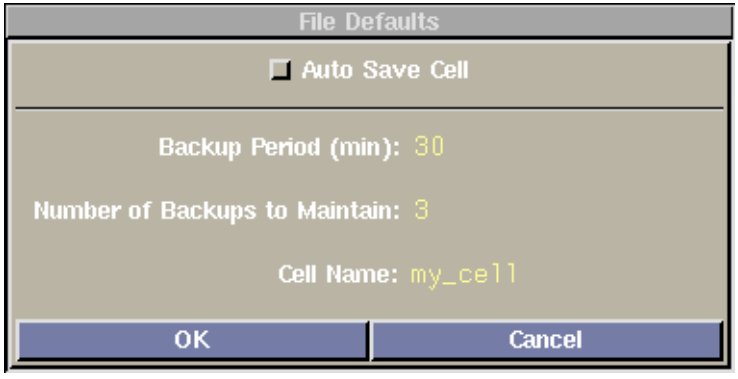


Figure 2-3 The File Defaults panel

❑ Auto Save Cell

Switching this on saves the workcell automatically.

Backup Period

Sets how often the backup copy of the workcell will be updated.

Number of Backups to Maintain

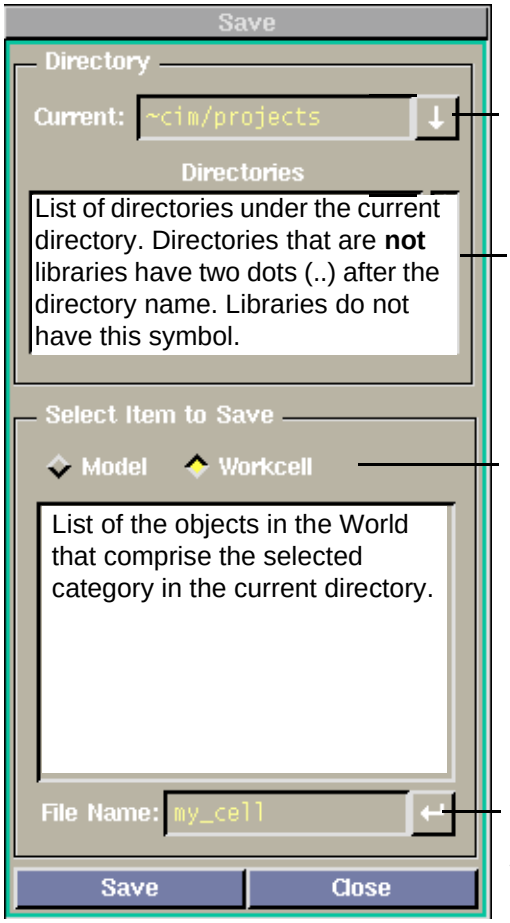
Specifies how many backup versions will be made. You can restore any of the backup versions. For example, after working a couple of hours you would have four versions of the workcell: **my_cell** (the original file), **my_cell1**, **my_cell2** and **my_cell3**.

Cell Name

Sets the filename that will be used to save the backup copy. The default is the current name of the workcell. The backup copy will not replace the workcell copy—a number will be appended to the filename. For example, the first backup will be saved as **my_cell1**. When you save the workcell using the Save panel, the original workcell file is updated.

Saving Your Work

The entire workcell can be saved, or the components can be saved in separate files, using the Save panel. Selecting *Save...* from the **File** pulldown menu displays the Save panel.


Save
Directory
Current:
~cim/projects
Directories
List of directories under the current directory. Directories that are not libraries have two dots (..) after the directory name. Libraries do not have this symbol.
Select Item to Save
Model
Workcell
List of the objects in the World that comprise the selected category in the current directory.
File Name:
my_cell
Save
Close

Sets the directory. You can use the list button to select **~cim/projects** or **~cim/users**, or use the field to enter any directory on the system. See “Libraries” on page 1-23.

Selecting a directory from this list makes it the current directory.

The toggle choices are the categories of the components of the World.

Saving the workcell does not adequately save the models. The models should be saved in separate files.

Filename that will be used to save the highlighted model or workcell.

Figure 2-4 The Save panel

Quitting Soft Machines

You can quit Soft Machines by selecting *Quit...* from the **File** pulldown menu.

Tool Bar Shortcut Clicking this tool bar button quits the session.

If you have made any modifications to the workcell or an object since the last save, a warning pops up.

If you have not made any modifications since the last save, you are asked to confirm that you want to exit Soft Machines.

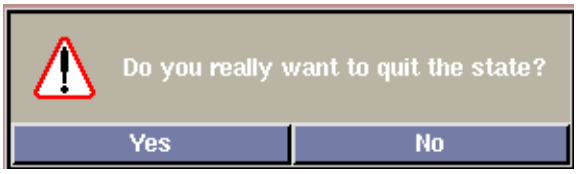


Figure 2-5 Quit confirmation

You can also quit Soft Machines by entering **quit();** at a SIL> prompt. In this case, no warning is issued, so make sure you have saved any changes.

Chapter 3

Modeling

Before conducting a Soft Machines simulation, you need to convert the relevant characteristics of the physical objects to be simulated into the internal representations which Soft Machines can recognize and process. This process is known as **modeling**. Soft Machines offers a basic modeling facility which you can use to define the form and structure of workcell objects.

Basic Principles

Most objects are made up of a number of components, each of which can be broken down into a number of components and so on until eventually, only simple one-piece parts remain. In Soft Machines, these separate parts are called **rigid models**. The assemblies that the rigid models comprise are called **non-rigid models**. All Soft Machines models are either rigid or non-rigid, and all non-rigid models are ultimately composed of rigid models.

Models are most conveniently represented by a model tree such as this one for a simple motor:

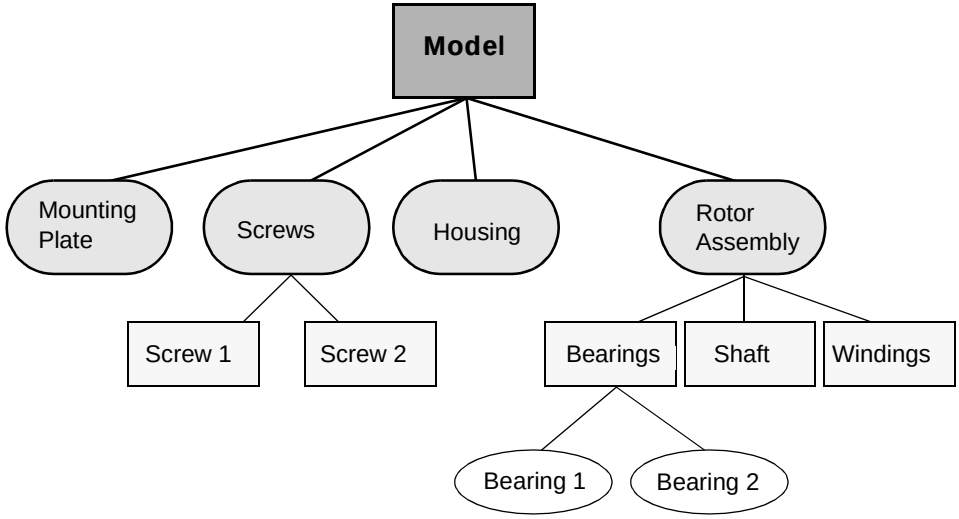


Figure 3-1 Model tree for a typical motor

The leaves of a tree such as that shown in Figure 3-2 are always rigid models, and the nodes of the tree are always non-rigid models. Each leaf or node is considered a model. A node includes all of the models in the tree below it. Likewise, any node is considered a component of the node above it. A model can consist of any number of nodes and leaves.

The Model Body

The model body is the description of the form of the model. The body of a model is another data structure containing all the volumes, surfaces, facets, edges, and points which compose the model. Soft Machines represents solid objects by using their bounding vertices, edges, and surfaces.

- A **point** is a set of X, Y, Z coordinates in 3D Cartesian space.
- An **edge** is a straight line segment connecting two points.
- A **facet** is a set of edges representing the boundary of a planar convex polygon. All facets have an inside and outside as defined by the direction of the positive normal to the polygon.
- A **surface** is represented by a set of facets, each approximating a part of the curve.
- A **volume** is a set of facets representing a convex polyhedron.

The body of a non-rigid model is often empty since the purpose of many structured models is to group rigid models (which have bodies) together in a cohesive fashion. In certain instances, however, you may wish to give a structured model a body.

Modeling Guidelines

You can model almost any object using the **Modeling** menu. There is no “best” way to build models, but a few guidelines may be helpful.

The most important rule is to keep models simple. Overly detailed models are inefficient, time consuming to create, and add nothing to the simulation except possible visual appeal.

When creating a model, you must decide upon an appropriate structure for the model. The structure determines the model's basic components and the assembly of these components. When determining the model's structure, take the model's purpose into consideration. For example, if you were constructing a robot that will disassemble a motor down to its mounting plate, rotor assembly, and housing, the rotor assembly need not be built as a structured model.

Build rigid models using basic components. Often, the basic components are fairly complex themselves, and are best constructed as rigid models. You can then include the rigid model in the basic component of which it is a part.

Using the Modeling Menu

The **Modeling** pulldown menu is used to construct Soft Machines models.

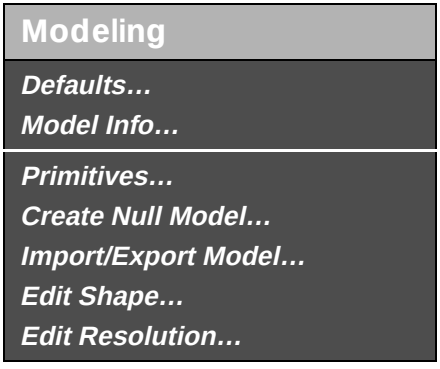


Figure 3-2 The **Modeling** menu

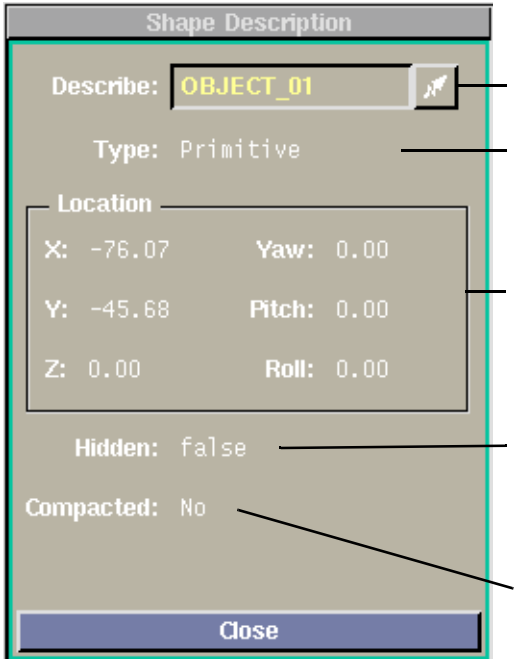
Table 3-1 describes the selections available from the **Modeling** menu.

Selection	Description
Defaults…	Displays the Modeling Defaults panel. See "Changing the Default Settings" on page 3-16.
Model Info…	Displays the Shape Description panel, which is used to obtain information about a model. See "Obtaining Information about a Shape" on page 3-5.
Primitives…	Displays the Add Primitives panel, which is used to add primitives to the workcell. See "Adding Primitives" on page 3-6.
Create Null Model…	Displays the Create Null Model panel. Clicking *OK* or *Apply* adds a null model to the World. The name used for the null model is specified in the Name field.
Import/Export Model…	Displays the CAD Interface panel, which is used to import models into Soft Machines and to export Soft Machines models. See Appendix A, "IGES Conversions".
Edit Shape…	Displays the Edit Shape panel. See "Editing a Shape" on page 3-10.
Edit Resolution…	Displays the Edit Resolution panel, which is used to modify segment length or facet size on parametric models. See "Editing the Resolution" on page 3-14.

Table 3-1 **Modeling** selections

Obtaining Information about a Shape

The Shape Description panel provides information about workcell objects. Selecting *Model Info...* from the **Modeling** pulldown menu displays the Shape Description panel.



Specifies which object will be described.

Displays the type of the object.

Displays location information with reference to the World. The location can be changed using the Move Object panel.

Displays whether the object is hidden or visible (controlled by the ◆ Visibility selection in the Appearance panel).

Displays whether the object is compacted or not (controlled by the ◆ Compact selection in the Edit Shape panel).

Figure 3-3 The Shape Description panel

Adding Primitives

The Add Primitives panel is used to add primitive shapes to the model. Selecting *Primitives...* from the **Modeling** pulldown menu displays the Add Primitives panel.

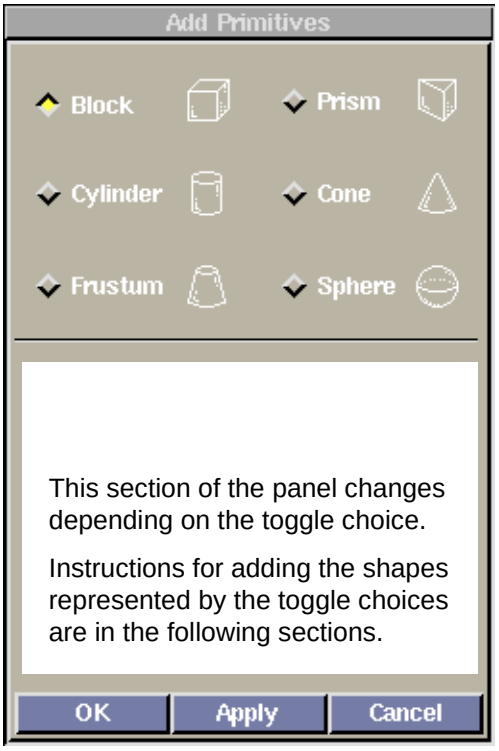


Figure 3-4 The Add Primitives panel

NOTE	The dimension fields in the selections to add primitives are in the current units. To change the units, see “Changing the Workcell Defaults” on page 5-4.

Adding a Block

Toggling ◆ Block displays the selections used for adding a block, along with a diagram showing the dimensions.

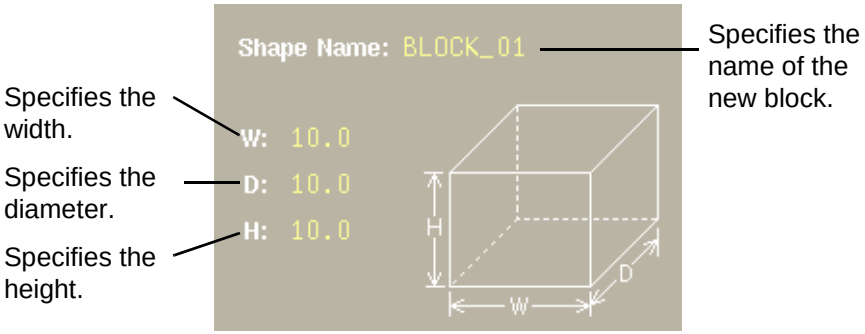


Figure 3-5 ◆ Block selections

Adding a Cone

Toggling ◆ Cone displays the selections used for adding a cone, along with a diagram showing the dimensions.

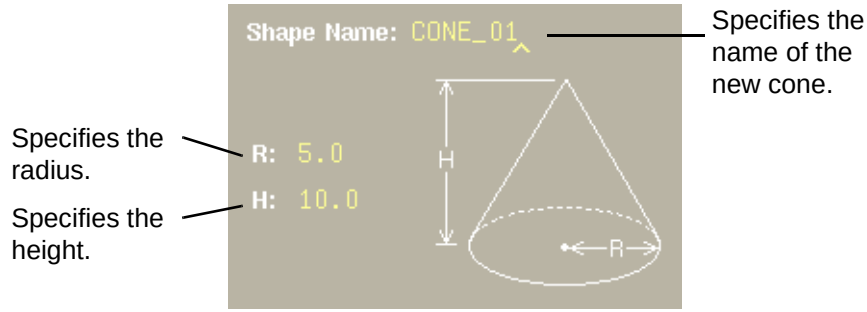


Figure 3-6 ◆ Cone selections

Adding a Cylinder

Toggling ◆ Cylinder displays the selections used for adding a cylinder, along with a diagram showing the dimensions.

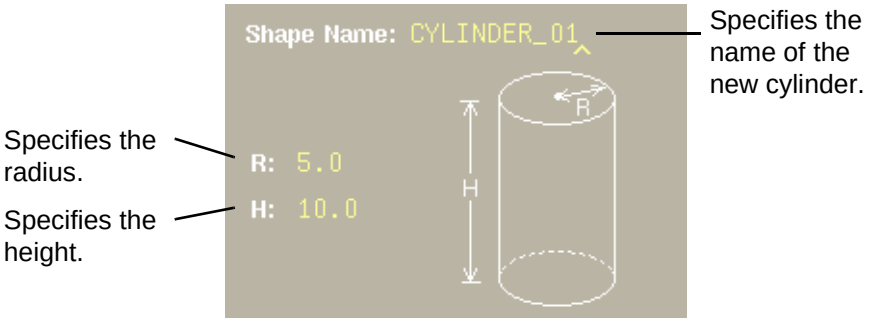


Figure 3-7 ◆ Cylinder selections

Adding a Frustum

Toggling ◆ Frustum displays the selections used for adding a frustum, along with a diagram showing the dimensions.

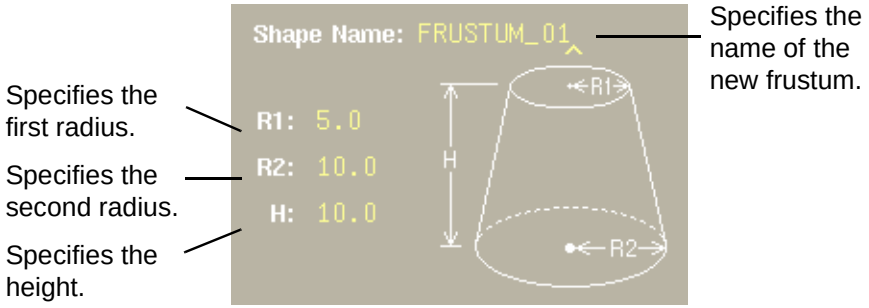


Figure 3-8 ◆ Frustum selections

Adding a Prism

Toggling ◆ Prism displays the selections used for adding a prism, along with a diagram showing the dimensions.

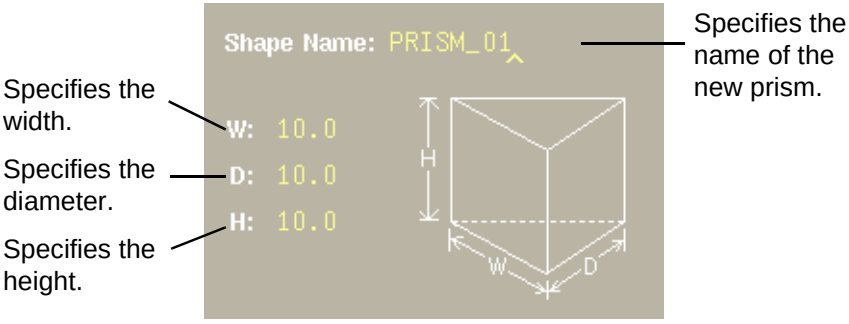


Figure 3-9 ◆ Prism selections

Adding a Sphere

Toggling ◆ Sphere displays the selections used for adding a sphere, along with a diagram showing the dimensions.

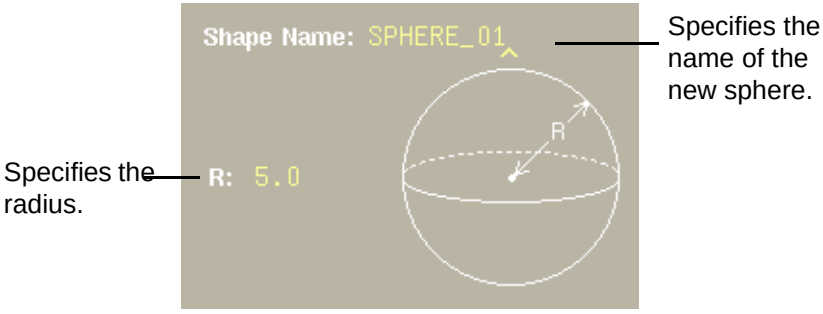


Figure 3-10 ◆ Sphere selections

Editing a Shape

You can change shapes using the Edit Shape panel. Selecting *Edit Shape...* from the **Modeling** pulldown menu displays the Edit Shape panel.

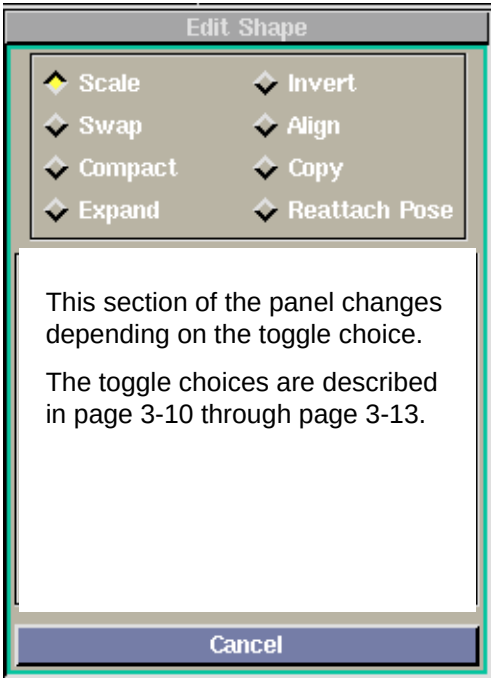


Figure 3-11 The Edit Shape panel

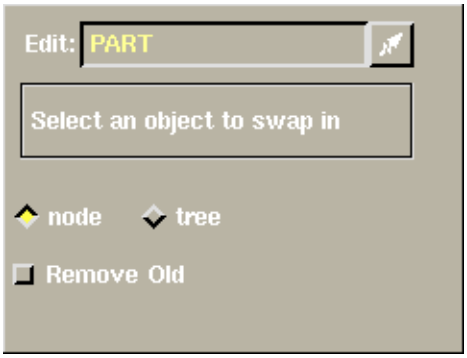
Scaling an Object

You can use ◆ Scale to scale an object uniformly in the X, Y, and Z directions.

1. Toggle ◆ Scale. Pick an object to scale and the Scale Factor field are displayed.
2. Enter a scale value in the Scale Factor field.
3. Select the object to be scaled from the *Graphics Window* or the *Quick Pick Window*.

Swapping Objects in a Model

Toggling ◆ Swap displays selections used to exchange the physical positions of objects in a model's object tree. **Swap** refers to the process of objects changing places with one another in the object tree.



Selecting an object from the *Graphics Window* or *Quick Pick Window* exchanges or replaces that object with the one specified in the Edit field.

Figure 3-12 ◆ Swap selections

Edit	Displays the name of the model to be changed.
◆ Node	The nodes that the objects occupy in their respective object trees will exchange places.
◆ Tree	The objects' trees will change places.
❑ Remove Old	If this is switched on, the selected object will replace the one specified with the Edit shape selector. If this is switched off, the two objects will exchange physical positions.

Compacting an Object

Toggling ◆ Compact provides selections for changing the tree structure of a specific model by creating a bond between objects. This bond can be removed by using ◆ Expand.

Select an object to compact from the *Graphics Window* or the *Quick Pick Window*.

Choose between two toggle choices: ◆ Rigid and ◆ Non-rigid.

◆ Rigid	Structures the tree of the selected object such that the child objects are considered to be affixed to the parent object, and are no longer considered separate entities. If the parent object moves, its children will move also. In addition, the children are not permitted to move relative to one another. You must move the parent to move the children. Using rigid compaction increases performance on certain platforms.
◆ Non-rigid	Structures the tree of the selected object such that the child objects are considered to be affixed to the parent object, but the child objects can still move relative to one another.

Expanding an Object

Toggling ◆ Expand removes the bonds created with ◆ Compact and returns objects to their original tree structure. Select an object to expand from the *Graphics Window* or the *Quick Pick Window*.

Inverting Objects

Toggling ◆ Invert inverts the facets of the selected object.

◆ Invert Model	Inverts all the facets of the selected object.
◆ Invert Facet	Inverts the selected facet.

Aligning Facets

The selections displayed by toggling ◆ Align are usually used to manipulate the facets of models that have been imported into Soft Machines through the CAD interface.

NOTE	To import models from IGES, see Appendix A, “IGES Conversions”.

After selecting the object to be modified using the Edit shape selector, toggle one of the choices described in Table 3-2.

Selection	Description
◆ Radial From Vertex	Select one of the object's vertices. The normals are aligned radially outward from the selected vertex.
◆ Radial From Edge	Select one of the object's edges. The normals are aligned radially outward from the selected edge.
◆ With Facet Normal	Select one of the faces of an object. The normals of the object's other facets are aligned with the normal of the selected face.
◆ Auto Align	Select one of the facets of an object. The normals of the object's other facets are aligned with the normal of the selected facet.

Table 3-2 ◆ Align selections

Copy

Toggling ◆ Copy and selecting an object from the *Graphics Window* or the *Quick Pick Window* creates a copy of the object.

Reattach Pose

Toggling ◆ Reattach Pose and selecting an object from the *Graphics Window* or the *Quick Pick Window* re-attaches the pose (or body-attached frame). Use this selection after you have moved the teacher to a new location because Soft Machines uses the teacher's location to re-define the object's pose.

Editing the Resolution

The Edit Resolution panel enables you to modify segment length or facet size on parametric models. Selecting *Edit Resolution...* from the **Modeling** pulldown menu displays the Edit Resolution panel.

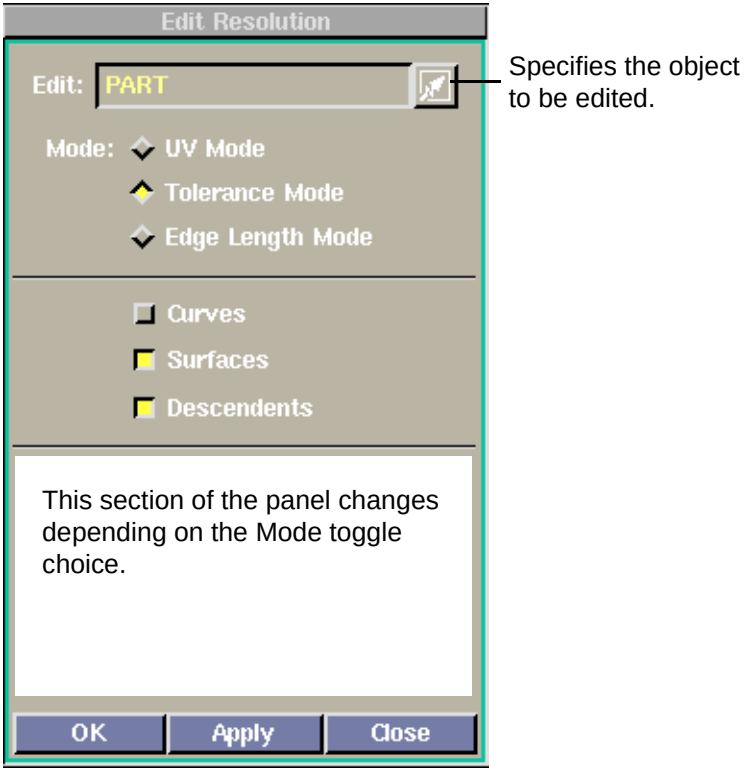


Figure 3-13 The Edit Resolution panel

Low resolutions (fewer facets) will speed up the graphics for large CAD models, however the models will look “rough”. High resolution will make the models look more real, but may slow the graphics of some platforms. Setting the proper resolution is important as it can achieve a good balance between performance and appearance.

Table 3-3 describes the three modes.

Selection	Description
◆ UV Mode	Specifies the facetization as a 2-dimensional grid. This is not recommended since it does not optimize the number of facets. You need to specify three fields: Surface U, Surface V and Boundary. Boundary is the resolution of the trimmed surface boundary.
◆ Tolerance Mode	Specifies the maximum allowable deviation of the faceted representation from the actual analytic surface. This optimizes the number of facets by creating more where the curvature is high, and fewer where surfaces are flat.
◆ Edge Length Mode	Specifies the size of the facets, but does not optimize.

Table 3-3 Modes

Table 3-4 describes the available switches that determine the kind of geometry that will be edited.

Selection	Description
❑ Curves	Edits resolution on curves according to the current mode.
❑ Surfaces	Edits resolution on surfaces according to the current mode.
❑ Descendents	Edits resolution on all the descendents of the selected shape.

Table 3-4 Geometry switches

Changing the Default Settings

Selecting *Defaults...* from the **Modeling** pulldown menu displays the Modeling Defaults panel.

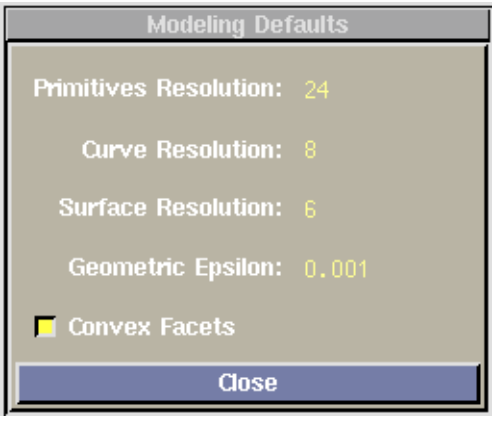


Figure 3-14 The Modeling Defaults panel

Table 3-5 describes the selections available from the Modeling Defaults panel.

Selection	Description
Primitives Resolution	Sets the number of facets for the certain primitives.
Curve Resolution	Sets the number of line segments of a curve when it is created.
Surface Resolution	Sets the number of facets a surface will have when it is created. The surface resolution in the U and V parameter direction is equal to this value.
Geometric Epsilon	Sets the value to be used as a geometry precision constant to compare “real” numbers.

Table 3-5 Modeling Defaults selections

Selection	Description
❑ Convex Facets	If switched on, all concave facets will become convex facets. This is necessary for reliable collision detection.

Table 3-5 Modeling Defaults selections (continued)

Where to Go From Here

To save models, see “Saving Your Work” on page 2-5.

To install models into the workcell, see “Installing Workcell Objects” on page 5-2.

To import models from IGES, see Appendix A, “IGES Conversions”. To import models from other CAD systems, see the *CAD Interfaces* manual, available from SILMA, Division of Adept Technology, Inc.

To change the color of models, see “Changing an Object’s Properties” on page 5-14.

To change the components of the models, such as adopting additional objects, see “Changing the Objects in the World” on page 5-11.

To change how the models are displayed, see “Display Options for the Workcell and Objects” on page 4-1.

Chapter 4

Graphics Display Options

The **Graphics** pulldown menu provides utilities to manipulate the Soft Machines graphics display, including changing the workcell perspective and lighting, adding additional *Graphics Windows* and changing how often the graphics are updated. The effect of these selections is only used to temporarily modify the graphics display for ease in performing certain functions. The settings revert to the default after you quit the session.

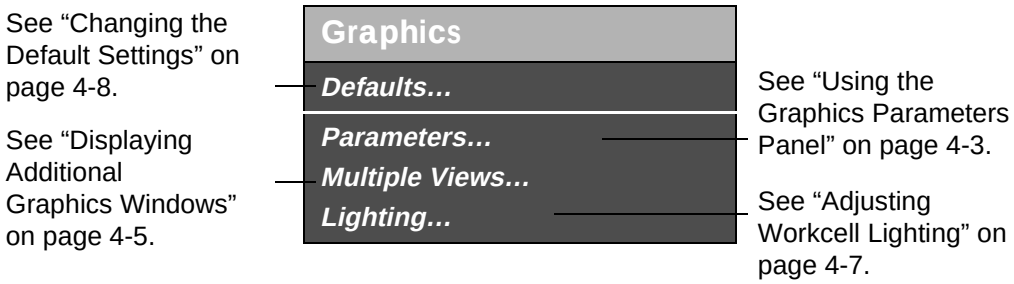

Graphics
Defaults…
Parameters…
Multiple Views…
Lighting…
See “Changing the Default Settings” on page 4-8.
See “Displaying Additional Graphics Windows” on page 4-5.
See “Using the Graphics Parameters Panel” on page 4-3.
See “Adjusting Workcell Lighting” on page 4-7.

Figure 4-1 The **Graphics** menu

Display Options for the Workcell and Objects

The Graphics Parameters panel is used to modify how the workcell and workcell objects are displayed. In order to understand the selections on this panel, you first need some information on how the display works.

Soft Machines supports two display modes for models: wireframe and surface. The wireframe representation is intended mainly to provide compatibility with existing wireframe models built on external CAD systems. Surfaced representation allows for more realistic display techniques using polygon filling.

You can set if a model is displayed in surface or wireframe by using the Display choices in the Graphics Parameters panel.

Wireframe Display Mode

In wireframe display mode, an edge is drawn only if it is one of the following:

- A wireframe element
- Associated with an edge of a forward-facing surface, and is not shared by an adjacent forward-facing surface of the same surface, (i.e., an edge caused by the segmentation of a smoothly curved surface)
- A **limb** (an edge along which a surface vanishes as it curves away from the viewer)

Surface Display Mode

In surface display mode, Soft Machines paints all facets which face the front of the display by beginning with the most distant one and working forward. With this method, facets in the foreground simply paint over the portions of facets in the background which they occlude.
Soft Machines shades surfaces by using a simulated light source, when one is provided.

NOTE You can add a light source by using the Lighting panel (see "Adjusting Workcell Lighting" on page 4-7).

In some cases, Soft Machines does not draw the edges associated with a facet. This method of displaying the edges of surfaces is called **backface elimination**. Although not as realistic as hidden line removal, backface elimination is a method of optimizing the display speed on platforms without hardware graphics support. To modify how backfaces are displayed, use the ◆ Backfacing Surfaces toggle choice in the Graphics Parameters panel.

Using the Graphics Parameters Panel

The Graphics Parameters panel modifies how the workcell and objects in the workcell will be displayed. Selecting *Parameters...* from the **Graphics** pulldown menu displays the panel. If you have more than one *Graphics Window* displayed, you can apply the Graphics Parameters selections to different *Graphics Windows*.

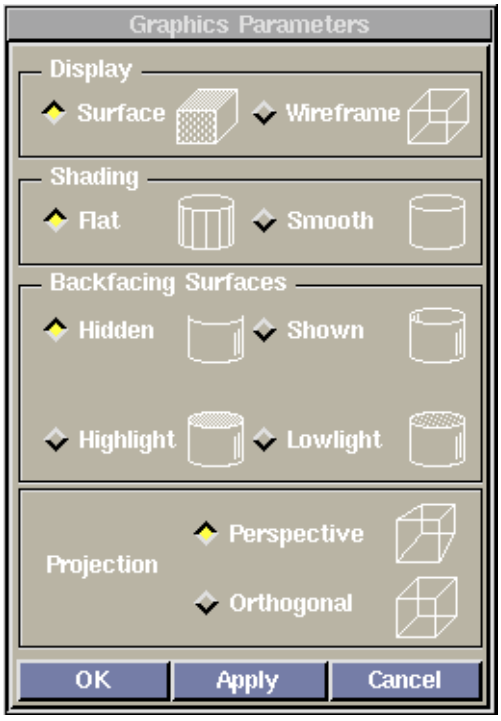


Figure 4-2 The Graphics Parameters panel

Display

Controls whether the surfaces of the objects are shown or only the outline.

- ◆ Surface Soft Machines displays only those lines at the front of workcell objects. Objects appear to be opaque. See “Surface Display Mode” on page 4-2.
- ◆ Wireframe Soft Machines displays all lines on workcell objects. Objects appear to be transparent. See “Wireframe Display Mode” on page 4-2.

Shading

These options only apply if ◆ Wireframe is toggled.

- ◆ Flat Shows the interior facets of objects as lines.
- ◆ Smooth Removes interior facets so the objects displayed in wireframe will look smooth.

Backfacing Surfaces

Controls how the edges of surfaces are displayed. See “Surface Display Mode” on page 4-2.

- ◆ Hidden Objects appear to be opaque.
- ◆ Shown Objects appear to be transparent.
- ◆ Highlight Backfaces are shown and highlighted intensely.
- ◆ Lowlight Backfaces are shown and highlighted, but less intensely.

Projection

Controls the perspective of how objects are displayed.

- ◆ Perspective Soft Machines displays the workcell in normal perspective.
- ◆ Orthogonal Soft Machines uses a non-perspective display.

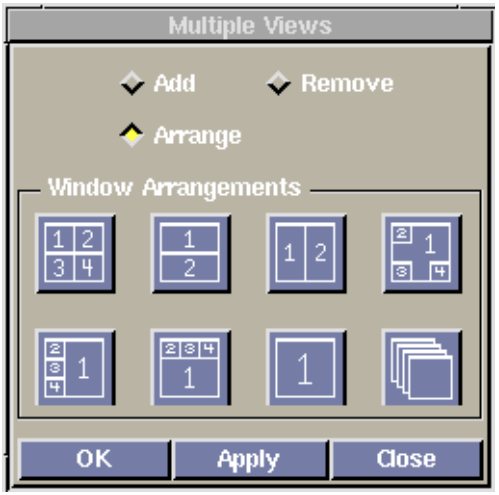
Displaying Additional *Graphics Windows*

You can display up to four *Graphics Windows*. By displaying different views of the workcell simultaneously, you can

- ➢ Look at a workcell from different angles
- ➢ Display more than one workcell
- ➢ Zoom in on an object in one window, while still being able to see the overall workcell in another window
- ➢ Apply the Graphics Parameters selections to different windows
- ➢ Have objects hidden and shown in different windows
- ➢ Change the lighting in different windows

NOTE	Hiding objects is done using the Appearance panel. See “Changing an Object’s Properties” on page 5-14. Changing the lighting is described in “Adjusting Workcell Lighting” on page 4-7.

The Multiple Views panel is used to add additional *Graphics Windows*, rearrange or delete them. Selecting *Multiple Views...* from the **Graphics** pulldown menu displays the Multiple Views panel.



Selections for arranging and sizing the *Graphics Windows*.

You can also use the left mouse button to rearrange or resize them.

Figure 4-3 The Multiple Views panel

Table 4-1 describes the selections available from the Multiple Views panel.

Selection	Description
◆ Add	Adds a *Graphics Window* and assigns it a View number. For example, the second window is added as View 2. This is illustrated in “The Soft Machines Display” on page 1-3.
◆ Remove	Displays a list of the views. Click on the view from the list and then click *Apply* to remove that window.
◆ Arrange	Displays different display options for arranging the *Graphics Windows*. See Figure 4-3 for options.

Table 4-1 Multiple Views selections

Adjusting Workcell Lighting

Selecting *Lighting...* from the **Graphics** pulldown menu displays the Lighting panel.

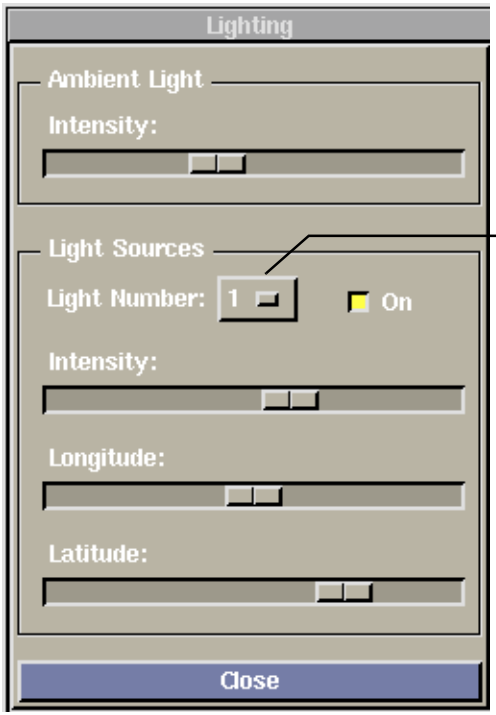


Figure 4-4 The Lighting panel

If you have more than one *Graphics Window* displayed, you can apply the Lighting selections to different *Graphics Windows*.

Changing the Default Settings

The Graphics Defaults panel is used to set the update rate, highlighting options and dynamic viewing. Selecting *Defaults...* from the **Graphics** pulldown menu displays the Graphics Defaults panel.

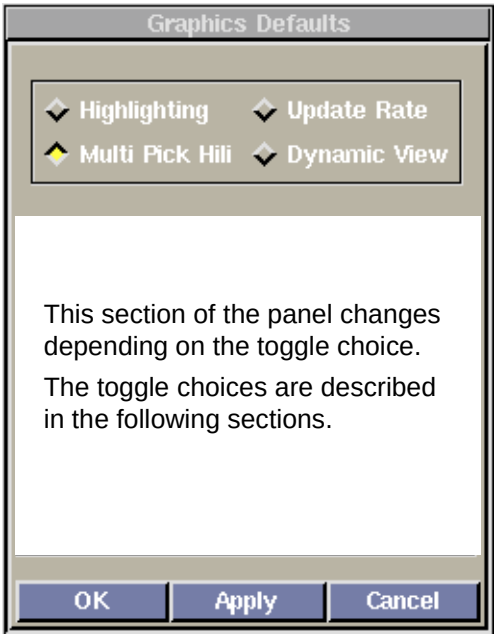


Figure 4-5 The Graphics Defaults panel

Setting Default Colors

Toggling ◆ Highlighting enables you to set the colors used to highlight objects and events in the *Graphics Window*.

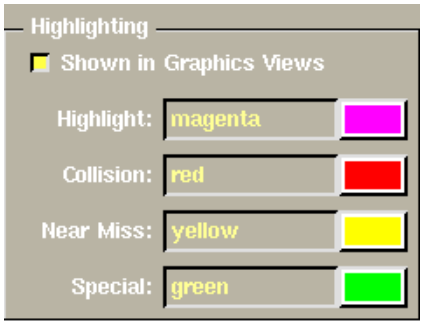


Figure 4-6 ◆ Highlighting selections

❑ Shown in Graphics Views

Sets whether the highlighting colors will be shown in the *Graphics Window*.

Highlight

Sets the primary highlighting color used for selected objects and groups.

Collision

Sets the color for collisions. Collision detection must be switched on to see the effect of this option (see “Collision Detection” on page 7-3).

Near Miss

Sets the color for near misses. ❑ Use Near Zone in the Collision Parameters panel must be switched on to see the effect of this option (see page 7-10).

Special

Sets the color for colliding surfaces. ❑ Surfaces in the Collision Parameters panel must be switched on to see the effect of this option (see page 7-9).

Multiple-Object Selection Highlighting

Toggling ◆ Multi Pick Hili enables you to set how the objects that have been selected during the multiple-object selection process are indicated. You have the choice of using an outline or a bounding box.

> **NOTE** For information on using multiple-object selection, see "Shape Selectors" on page 1-15.

Setting the Update Rate

The **update rate** sets how often the *Graphics Window* will be refreshed. If the update rate is a small value, the system will slow down to accommodate the frequent refreshes.

Toggling ◆ Update Rate enables you to set the update rate.

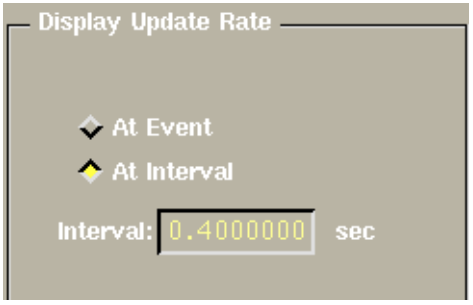


Figure 4-7 ◆ Update Rate selections

> **NOTE** This setting is also used in collision detection if the Check At parameter in the Collision Parameters panel is set to ◆ Refresh.

Dynamic View

Toggling ◆ Dynamic View displays the ❑ Enabled switch. Switching this on changes objects to wireframe display (if wireframe is available). When switched off, objects return to their original display.

Chapter 5

Constructing the Workcell

After creating the models, you need to install them into the workcell, and then construct the workcell.

A complete workcell contains

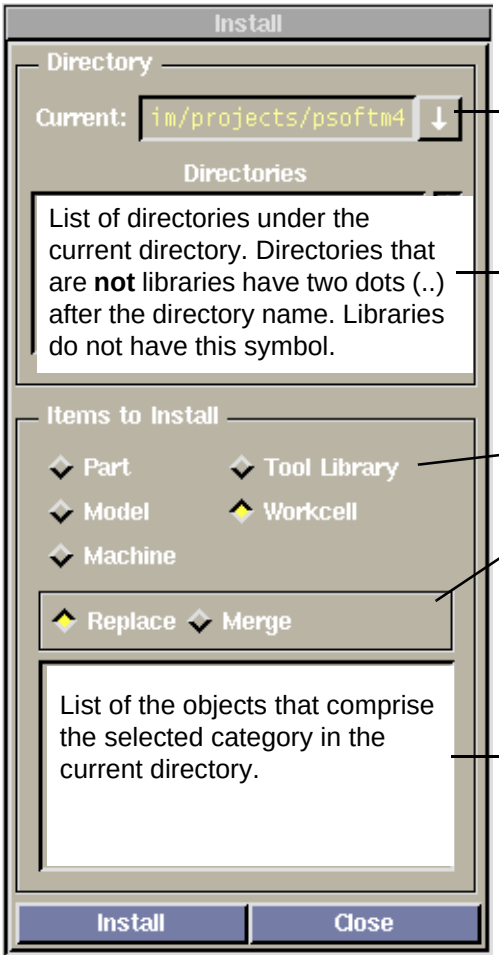
- All the objects necessary for the simulation
- Locations of all the objects relative to the World coordinate system
- Object colors
- Affixment relations with other objects in the cell
- Views from which the workcell can be viewed

When you have completely set up the workcell, you can save it in a Soft Machines library to use later.

NOTE For information on saving your cell, see “Saving Your Work” on page 2-5.

Installing Workcell Objects

The first step in laying out your workcell is to install the objects by using the Install panel. The Install panel can be displayed by selecting *Install...* from the **File** pulldown menu.



Sets the directory. You can use the list button to select **~cim/projects** or **~cim/users**, or use the field to enter any directory on the system. See "Libraries" on page 1-23.

Selecting a directory from this list makes it the current directory.

This toggle choice sets what you would like to install.

Toggling ◆ Workcell displays the Replace/Merge toggle.

◆ Replace replaces the entire contents of the cell.

◆ Merge merges the selected workcell with the current one.

The list is compiled from the file extensions of the files. See Table 1-2, "Libraries and filename extensions" on page 1-24.

Figure 5-1 The Install panel

Tool Bar Shortcut Clicking this tool bar button displays the Install panel.

Models of parts should be installed with ◆ Part toggled to identify them as parts. A model installed with ◆ Part toggled is added to the workcell under a null model labeled part. Children of this null model will be used by First Cut in determining the stock bounding box.

> **NOTE** If you are using a workcell created with a pre-1.7 version of Soft Machines, you need to add the part null model to the workcell. This procedure is described on page 3-4.

Using the Layout Menu

After adding the objects to the workcell, they need to be arranged into the correct positions. The primary menu you will use to set up and organize your workcell is the **Layout** menu.

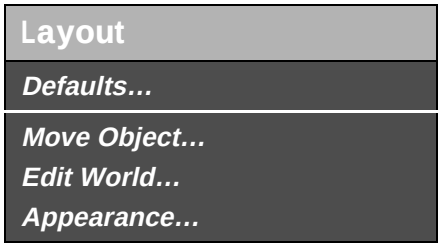


Figure 5-2 The **Layout** menu

Table 5-2 describes the selections, and tells you where to look for further information.

Selection	Description
Defaults…	Shows the reference frame and changes workcell units. See “Changing the Workcell Defaults” on page 5-4.
Move Object…	Moves objects. See “Moving Objects” on page 5-5.
Edit World…	Re-defines the relationships of objects, such as their affixments. See “Changing the Objects in the World” on page 5-11.

Table 5-2 **Layout** selections

Selection	Description
Appearance…	Displays the Appearance panel. See “Changing an Object’s Properties” on page 5-14.

Table 5-2 **Layout** selections (continued)

Changing the Workcell Defaults

The Layout Defaults panel is used to set the workcell units and the reference frame. Selecting *Defaults…* from the **Layout** pulldown menu displays the Layout Defaults panel.

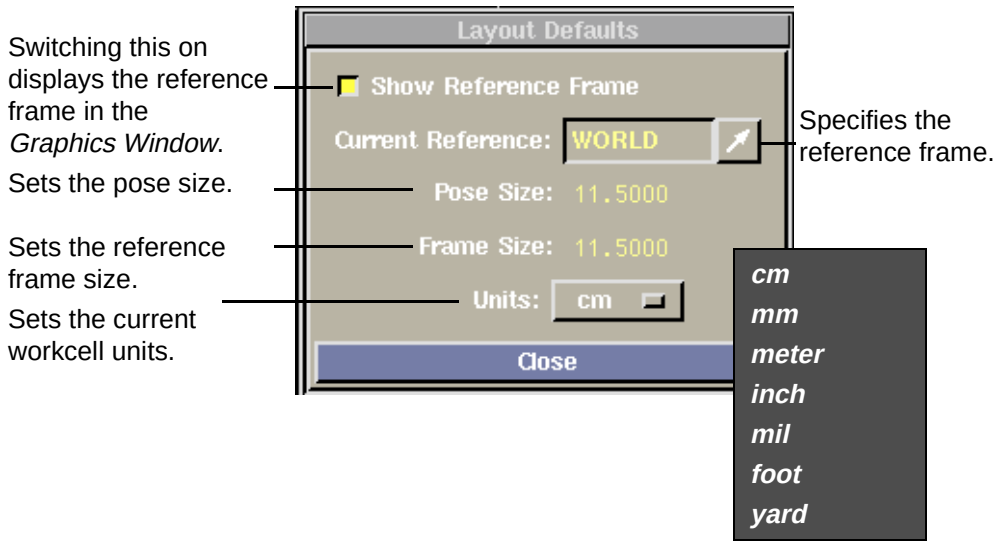


Figure 5-3 The Layout Defaults panel.

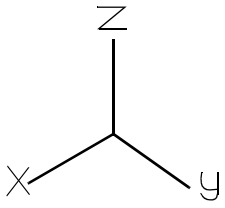


Figure 5-4 The reference frame

Moving Objects

The Move Object panel is displayed by selecting *Move Object...* from the **Layout** menu.

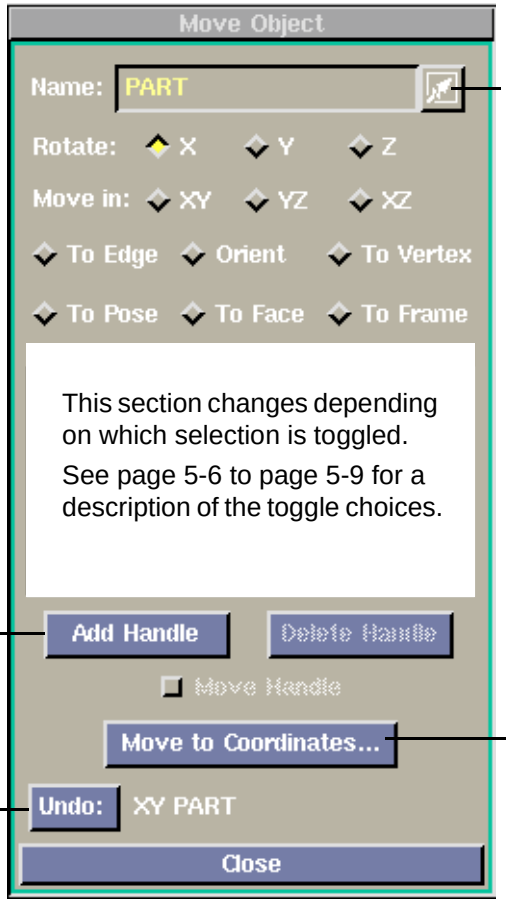

Move Object
Name: PART
Rotate: X Y Z
Move in: XY YZ XZ
To Edge Orient To Vertex
To Pose To Face To Frame
This section changes depending on which selection is toggled.
See page 5-6 to page 5-9 for a description of the toggle choices.
Add Handle
Delete Handle
Move Handle
Move to Coordinates...
Undo: XY PART
Close
Selects the object to be moved.
See "Using the Handle" on page 5-9.
See "Moving to Coordinates" on page 5-10.
Undoes the displayed move.

Figure 5-5 The Move Object panel

Tool Bar Shortcut Clicking this tool bar button displays the Move Object panel.

Rotating Objects

Toggling ◆ X, ◆ Y, or ◆ Z in the Rotate section of the Move Object panel displays a circle around the object in the *Graphics Window* and the appropriate selections in the middle of the panel. Using these selections, you can rotate the current object around the appropriate object.

Specifies whether the current object rotates around the current reference frame or itself.

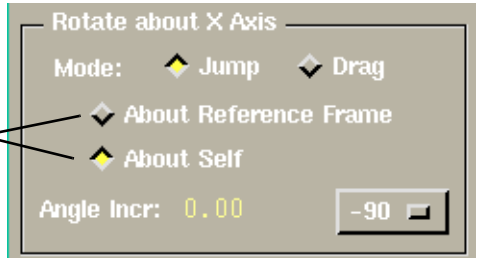


Figure 5-6 The Rotate about X Axis box

By positioning the cursor in the *Graphics Window* and holding down the left mouse button, you can drag the cursor to a different rotation. Releasing the mouse button rotates the object.

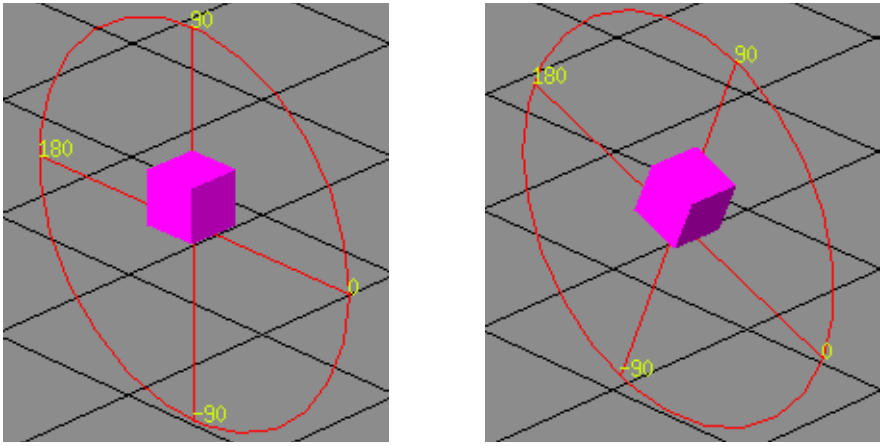


Figure 5-7 Rotating an object

There are two modes to determine how the object will be rotated: ◆ Jump, or ◆ Drag.

- ◆ Jump — Uses angle increments entered in the Angle Incr field.
- ◆ Drag — Uses the mouse cursor to rotate the object in the *Graphics Window*.

Moving an Object in a Plane

Toggling ◆ XY, ◆ YZ, or ◆ XZ in the Move in section of the Move Object panel displays a cross on the object in the *Graphics Window* and the appropriate selections in the middle of the panel. Using these selections, you can move the current object in the XY, YZ, or XZ planes.

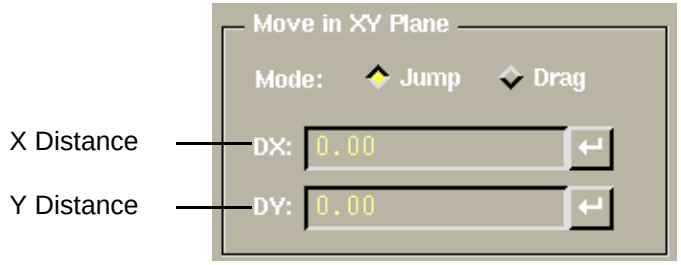


Figure 5-8 The Move in XY Plane box

By positioning the cursor in the *Graphics Window* and holding down the left mouse button, you can drag the cursor to the new location. Releasing the mouse button moves the object.

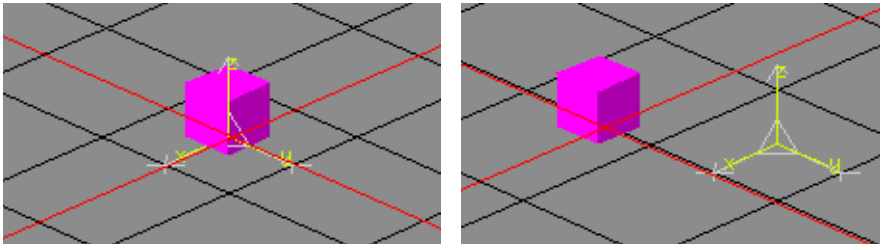


Figure 5-9 Moving an object in the XY plane

There are two modes to determine how the object will be moved: ◆ Jump, or ◆ Drag.

- ◆ Jump — Uses distance values entered in the DX and DY fields.
- ◆ Drag — Uses the mouse cursor to move the object in the *Graphics Window*.

Moving an Object to the Edge of an Object

Toggling ◆ To Edge in the Move Object panel and clicking on the edge of a workcell object in the *Graphics Window* moves the designated workcell object to that edge. If ❑ Center on Edge is switched on, the object will be moved to the center of the edge.

Moving an Object to the Pose of an Object

Toggling ◆ To Pose in the Move Object panel and clicking on the pose of a workcell object in the *Graphics Window* moves the current object to the selected pose.

Aligning an Object

Toggling ◆ Orient in the Move Object panel displays the Align with selections, which are used to align the current object with the edge, face, frame, or pose of a workcell object that you pick in the *Graphics Window*. You can also use ◆ Bisect Faces or ◆ Bisect Edges to move the current object to another workcell object such that their specified faces or edges bisect.

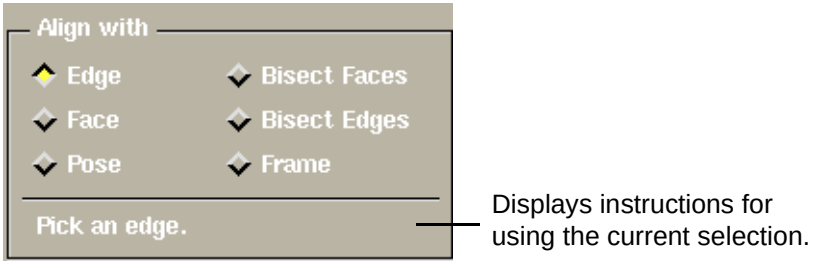


Figure 5-10 The Align with selections

Moving an Object to the Face of an Object

Toggling ◆ To Face in the Move Object panel and clicking on the face of a workcell object in the *Graphics Window* moves the designated workcell object to that face.

There are two options. If ❑ Center on Face is switched on, the object will be moved to the center of the face. If ❑ Align with Face is switched on, the object will be aligned with the face.

Moving an Object to the Vertex of an Object

Toggling ◆ To Vertex in the Move Object panel and clicking on the vertex of a workcell object in the *Graphics Window* moves the designated workcell object to that vertex.

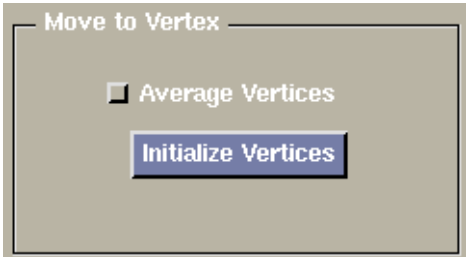


Figure 5-11 The Move to Vertex box

Moving an Object to the Frame of an Object

Toggling ◆ To Frame in the Move Object panel and clicking on the frame of a workcell object in the *Graphics Window* moves the designated workcell object to that frame.

Using the Handle

If you want to move an object relative to a position other than its pose, you can use its "handle".

Clicking *Add Handle* adds a handle to the selected part.

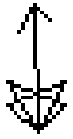


Figure 5-12 The handle

Switching on ❑ Move Handle applies the Move Object selections to the handle. Switch off ❑ Move Handle to move the part.

Any moves of the part will be made with respect to the handle position—if you move the part to the pose of the teacher, the handle will be aligned to the pose of the teacher.

Clicking *Delete Handle* removes the handle.

Moving to Coordinates

Selecting *Move to Coordinates...* from the Move Object panel displays the Move to Coordinates in Reference panel. The Translate fields move the object to the specified coordinate relative to the current reference frame. The Rotate fields rotate the object relative to the current reference frame.

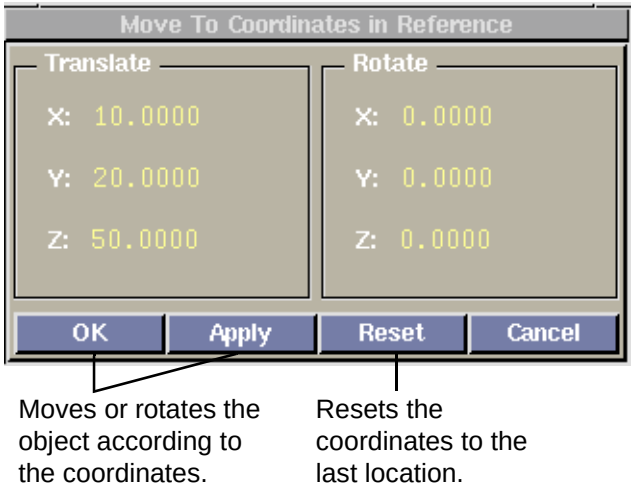


Figure 5-13 The Move to Coordinates in Reference panel

Changing the Objects in the World

The Edit World panel is used to change the components of the World. Objects can be bonded together, renamed or deleted from the World. The Edit World panel can be displayed by selecting *Edit World...* from the **Layout** menu.

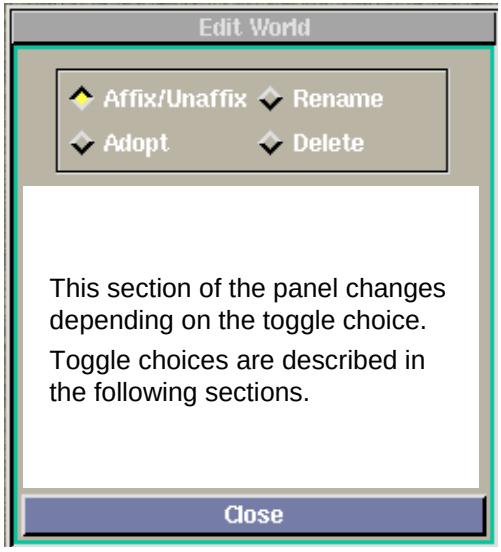


Figure 5-14 The Edit World panel

Tool Bar Shortcut Clicking this tool bar button displays the Edit World panel.

Creating and Removing Affixments

◆ Affix/Unaffix in the Edit World panel is used both to temporarily bond two objects together or to remove this bond. Toggling ◆ Affix/Unaffix then selecting an object affixes that object to the object displayed in the Affix to field. If an object is already affixed, toggling ◆ Affix/Unaffix then selecting an object removes the affixment.

Adopting Objects

Adopting refers to the process of changing Soft Machines's object tree. When one object adopts another, it becomes the "parent" object. The adoptee or "child" object is then below the parent object in the object tree. This arrangement results in the child object being a component of the parent object—the child object moves when the parent object moves.

In the model tree shown in Figure 3-1, "Model tree for a typical motor" on page 3-1, **model** is the parent object of all of the motor's parts. Because **mounting plate** has no parts below it on the object tree, it is not a parent object—it is a child only. The **screws** and **rotor assembly**, however, do have parts below them on the object tree; therefore, they are considered parent objects. They are also child objects because they are below **model** in the object tree.

To create this model using the ◆ Adopt selection:

1. Install all the objects included in the model. The objects are shown in the *Quick Pick Window* as being on the same level.

2. Toggle ◆ Adopt in the Edit World panel. The object which will be the parent is displayed in the Parent field. Use the middle mouse button to select model from the *Graphics Window* or the *Quick Pick Window*.

3. Use the left mouse button to select the children to adopt (mounting plate, screws, housing, rotor assembly) from the *Graphics Window* or the *Quick Pick Window*. The *Quick Pick Window* is updated.

4. Use the middle mouse button to select the next-level parents (the previous children) and the left button to select their children.

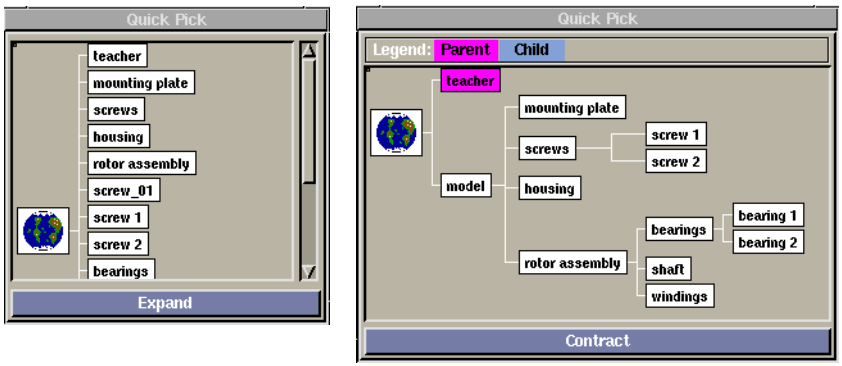


Figure 5-15 The *Quick Pick Window* before and after adopting objects

Renaming Objects

◆ Rename renames an object selected from the *Graphics Window* or the *Quick Pick Window*. A pop up box will request the new name.

Deleting Objects from the World

◆ Delete deletes an object from the World. If the object has been saved, it can be installed again. If the object has not been saved, it is deleted permanently.

NOTE Saving the workcell does not adequately save the object. To install an object, it must have been saved as a separate file.

You can remove everything in the workcell by clicking on the World icon in the *Quick Pick Window*.

Changing an Object's Properties

The Appearance panel is used to alter an object's properties: color, material, transparency and visibility. If you save the workcell, the current appearances of the objects is saved with the cell. In the case of color, material, and transparency, you can permanently alter the object by saving it. The Appearance panel can be displayed by selecting *Appearance…* from the **Layout** menu.

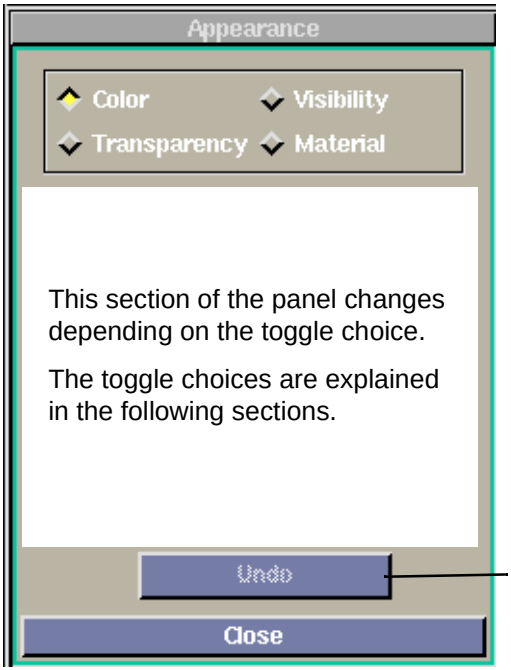


Figure 5-16 The Appearance panel

Tool Bar Shortcut Clicking this tool bar button displays the Appearance panel.

Applying Colors

Toggling ◆ Color paints objects or changes the background color. This property is saved when the workcell is saved and saving the object permanently changes its color.

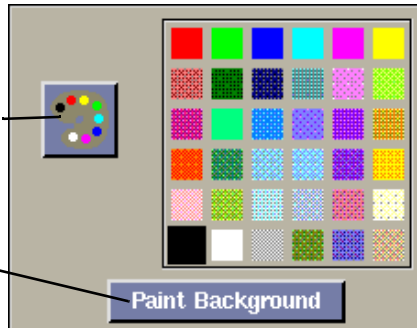

Displays the Color Wheel panel.
Applies the selected color to the background.
Paint Background
Available colors in the current palette. Each color can be changed by using the Color Wheel panel.

Figure 5-17 ◆ Color selections

The Color Wheel panel is used to change the colors in the palette. Clicking this button in the ◆ Color selections displays the panel.

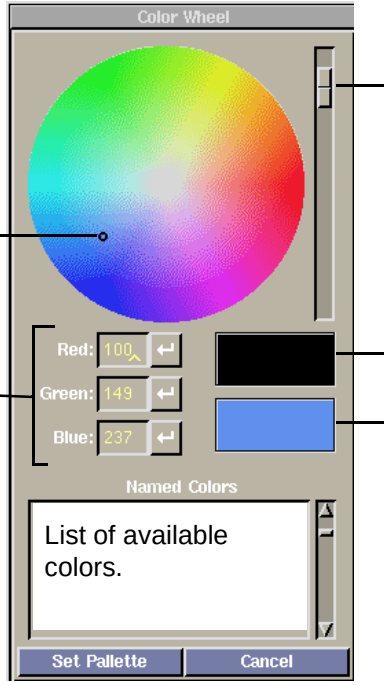


Figure 5-18 The Color Wheel panel

Visibility

Toggling ◆ Visibility displays the visibility selections.

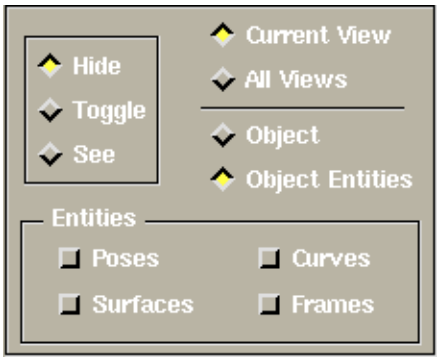


Figure 5-19 ◆ Visibility selections

The Hide/Toggle/See toggle sets whether the object or object entity is to be hidden or shown. Hidden objects are not removed from the workcell. The ◆ Toggle selection changes the object's visibility back and forth—for example, if the object is hidden, ◆ Toggle shows it.

NOTE The reference frame is hidden by switching off ❑ Show Reference Frame in the Layout Defaults panel.

The Object/Object Entities toggle sets the workcell component that will be affected by the Hide/See toggle. Toggling to ◆ Object enables you to choose an object. Toggling ◆ Object Entities displays the object entity selections: ❑ Poses, ❑ Surfaces, ❑ Frames, ❑ Curves.

The Current View/All Views toggle is used if you have more than one *Graphics Window* displayed. Toggling ◆ Current View applies your selections only to the current view of the workcell. Toggling ◆ All Views applies your selections to all the views of the workcell.

NOTE To display additional *Graphics Windows*, see "Displaying Additional Graphics Windows" on page 4-5.

Transparency

Toggling ◆ Transparency is used to make an object appear transparent. This property is saved when the workcell is saved and saving the object permanently alters how transparent it is.

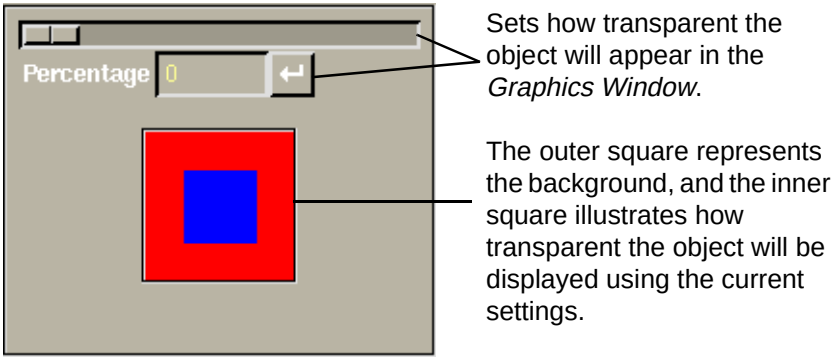

Percentage
0
Sets how transparent the object will appear in the *Graphics Window*.
The outer square represents the background, and the inner square illustrates how transparent the object will be displayed using the current settings.

Figure 5-20 ◆ Transparency selections

First set the percentage using the slider or Percentage field, then click on an object in the *Graphics Window* or the *Quick Pick Window*. If Percentage is 100% transparent, only the outline of the object will be displayed. To set it back, make the percentage 0, then click on the object.

NOTE	Although this selection is available on all platforms, you may not see the effect on certain platforms. You might also consider using the ◆ Wireframe selection in the Graphics Parameters panel (see "Display Options for the Workcell and Objects" on page 4-1).

Material

Besides color and transparency, a surface object can have a material associated to it. Different materials show different lighting effects. Three choices are available to simulate plaster, plastic, or metal. Toggling ◆ Material displays the toggle choices:

- ◆ Default — Non-shiny and bright (plaster).
- ◆ Plastic — Shiny but dim.
- ◆ Metal — Shiny and bright.

This property is saved when the workcell is saved and saving the object permanently changes its material.

Chapter 6

Modeling NC Tooling

The Tooling Assembly

Before a machine tool can perform any machining operations, tooling must be mounted to the machine. In Soft Machines, NC tooling (tool changers, tool holders and cutters) are modeled and saved as **tool libraries**. When part programs are loaded for simulation, the appropriate tool libraries must be installed into the workcell and attached to the machine tool model. Figure 6-1 illustrates the tool library components:

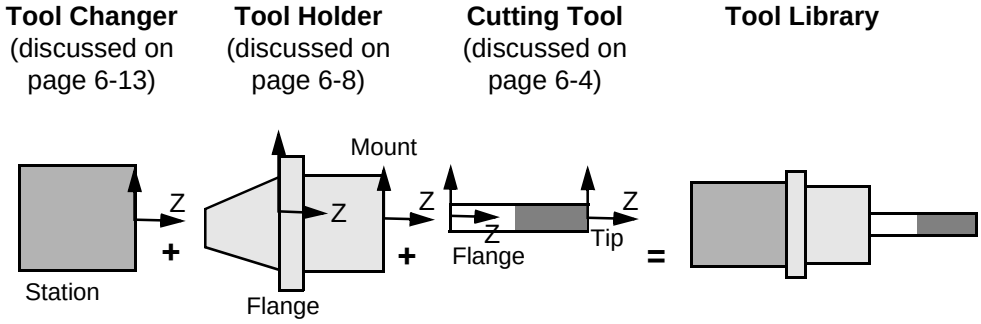


Figure 6-1 Tool library components

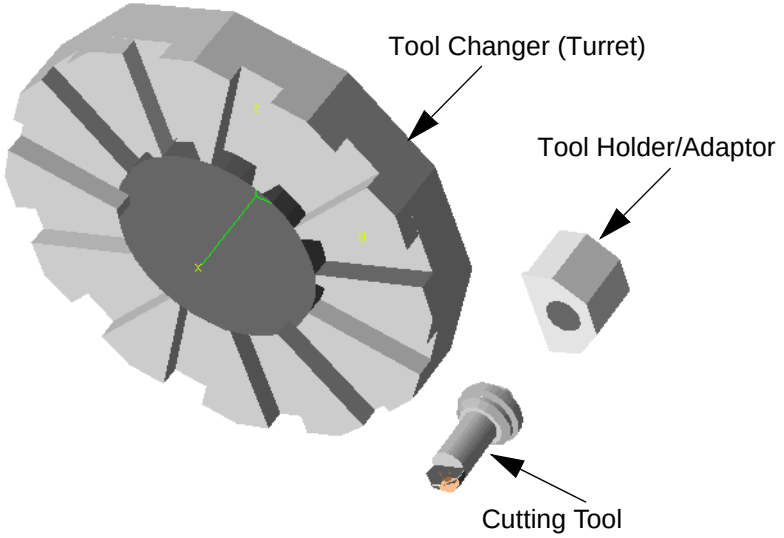


Figure 6-2 NC tooling: tools for turning

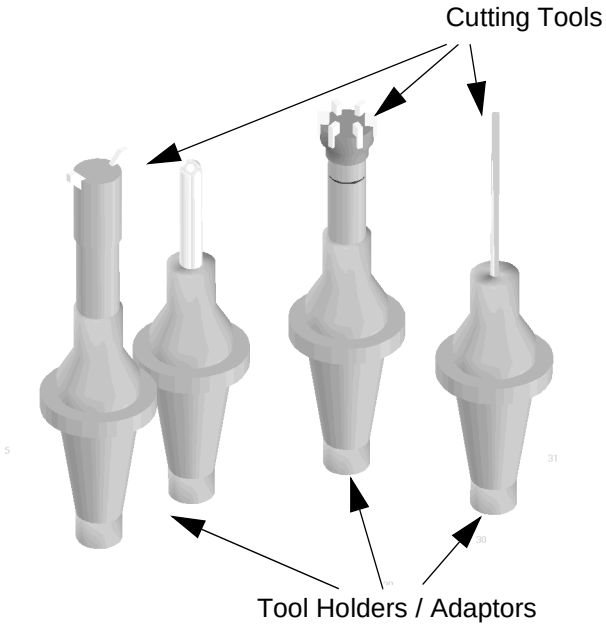


Figure 6-3 NC tooling: tools for a machining center

Tooling is set up by using the Tool Setup panel. Selecting *Tooling Setup...* from the **Simulate** pulldown menu displays the Tool Setup panel.

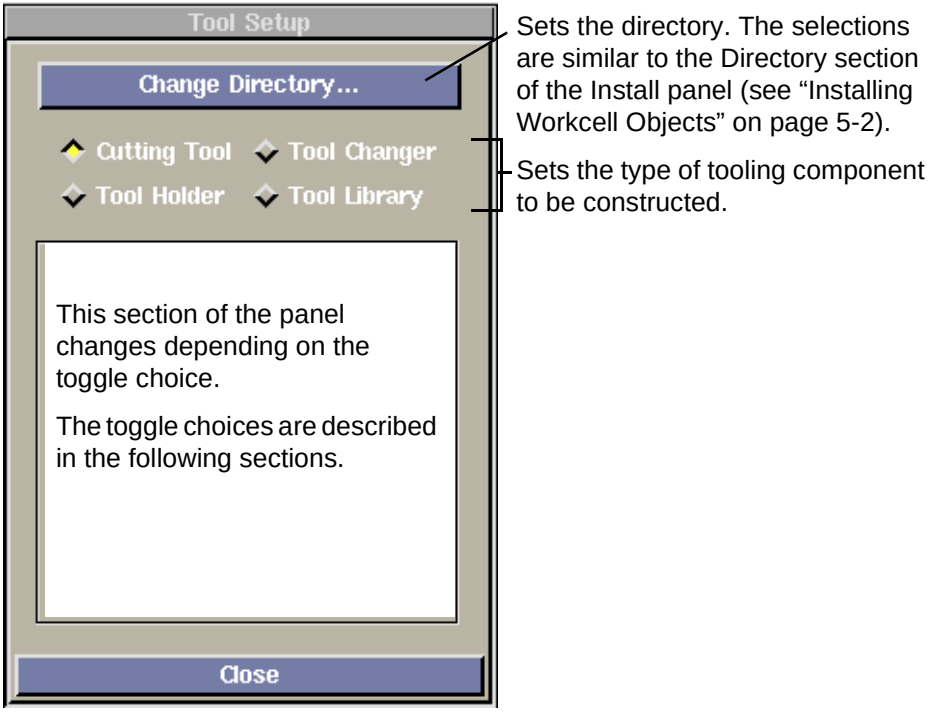

Tool Setup
Change Directory...
Cutting Tool
Tool Changer
Tool Holder
Tool Library
This section of the panel changes depending on the toggle choice.
The toggle choices are described in the following sections.
Close
Sets the directory. The selections are similar to the Directory section of the Install panel (see “Installing Workcell Objects” on page 5-2).
Sets the type of tooling component to be constructed.

Figure 6-4 The Tool Setup panel

Tool Bar Shortcut Clicking on this tool bar button displays the Tool Setup panel.

Cutting Tools

A **cutting tool** is a cutter that performs the actual machining operations.

NOTE	Figure 6-1, “Tool library components” on page 6-1 illustrates how cutting tools are used with other tooling components.

Toggling ◆ Cutting Tool in the Tool Setup panel displays the selections for tool cutters.

There are two methods for creating a cutting tool:

- ◆ Use Model in World is used to create a cutting tool from a workcell object (see “Creating a Cutting Tool from a Model” in the following section).
- ◆ Use Parameters is used to automatically create end mills and shell mills from specified parameters.

Creating a Cutting Tool from a Model

◆ Use Model in World is used to convert a workcell object into a cutting tool. Cutting tools modeled in another CAD package can be imported into the workcell through the CAD Interfaces panel, and then converted into Soft Machines tools using these panel selections.

Figure 6-5 ◆ Use Model in World selections

Table 6-1 describes the ◆ Use Model in World selections.

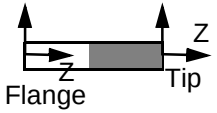
Selection	Description
Name	Specifies the Soft Machines model to be converted to a cutting tool.
◆ Define Tip	Defines the cutting tip of the cutter. Selection is made by clicking on a frame or an object from the *Graphics Window*. The pose of the selected object defines the cutting tip. 
◆ Define Flange	Defines the flange pose of the cutter. The flange specifies the mount location of the cutter to the tool holder/adaptor mount frame.
Save as Cutting Tool…	Displays a name requestor, which is used to specify the filename of the new cutter. The filename will be appended with a **`.ct`** file extension, and saved in the **`nc_tooling`** subdirectory of the current library.

Table 6-1 ◆ Use Model in World selections

Modeling an End Mill Cutter

Highlighting End Mill from the list displayed by toggling
◆ Use Parameters displays the End Mill panel.

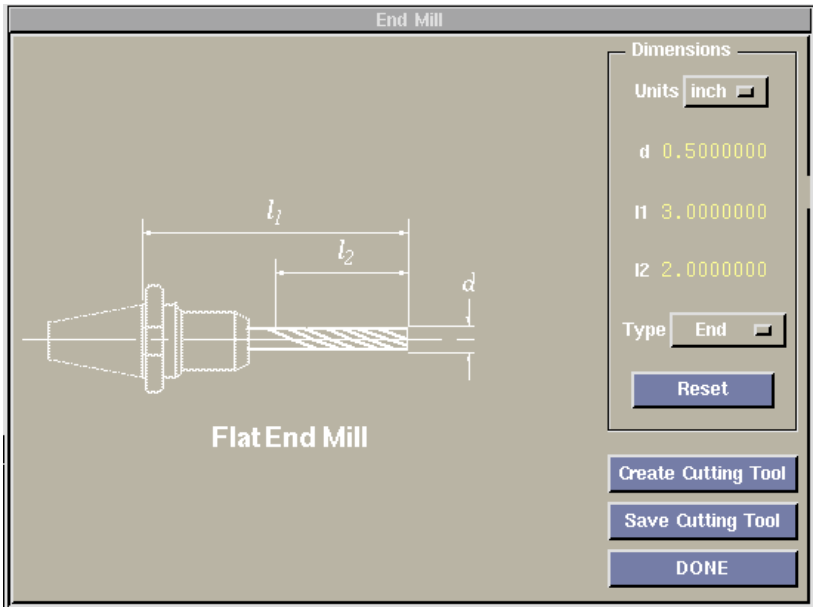
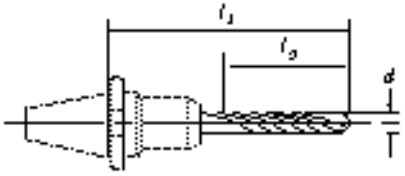


Figure 6-6 The End Mill panel

Type sets the type of end mill that will be created. *End*, which is used to create a flat end mill, is shown in Figure 6-6. Setting Type to *Ball* displays the diagram for a spherical end mill:



Creating a radius end mill is also possible by setting Type to *Radius*.

The End Mill panel contains these parameters:

- d diameter
- l1 gauge length of cutter
- l2 length of flutes

Units defines units used for d, l1 and l2. There are two choices: *inch* or *mm*.

Modeling a Shell Mill Cutter

Highlighting Shell Mill from the list displayed by toggling ◆ Use Parameters displays the Shell Mill panel.

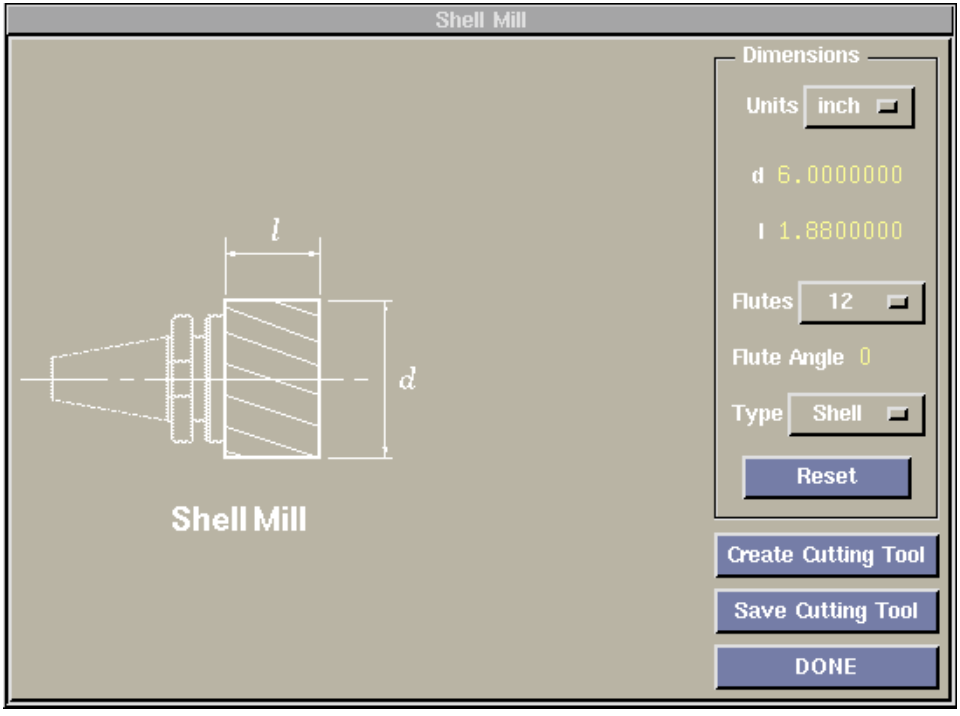


Figure 6-7 The Shell Mill panel

Units defines units used for d and l. There are two choices: *inch* or *mm*.

Flutes defines number of flutes on cutter. Choices are *6, 8, 10, 12, 14, 16, 18, 20*.

Modeling a Drill Cutter

Highlighting Drill from the list displayed by toggling ◆ Use Parameters displays the Drill panel.

Tool Holder

A **tool holder** is used as a tool holding device for cutting tools. Examples of tool holders include drill chucks, collets, and V-flange adapters. For a machining center, tool holder/cutting tool assemblies are usually mounted on a tool magazine when not performing machining operations. An automatic tool changer will mount the tool holder to the machine spindle when a tool-change command is executed.

NOTE Figure 6-1, “Tool library components” on page 6-1 illustrates how tool holders are used with other tooling components.

Toggling ◆ Tool Holder in the Tool Setup panel displays the selections for tool holders.

Uses a workcell object as a tool holder. See “Creating a Tool Holder from a Model” on page 6-9.

Creates a tool holder from specified parameters. See “Modeling Adaptors Using Parameters” on page 6-9.

Saves the model as a tool holder.

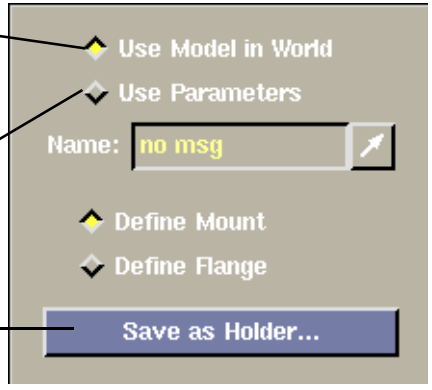


Figure 6-8 ◆ Tool Holder selections

Creating a Tool Holder from a Model

Toggling ◆ Use Model in World displays the selections for specifying a workcell object to be recognized as a tool holder. Table 6-2 describes the ◆ Use Model in World selections.

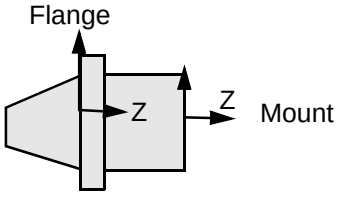
Selection	Description
Name	Specifies the Soft Machines model to be converted into a tool holder.
◆ Define Mount	Defines the pose of the mount point of the tool holder. Selection is made by clicking on a frame or an object from the *Graphics Window*. If an *object* is selected, the pose of the object defines the mount location. 
◆ Define Flange	Defines the flange pose of the tool holder. The flange specifies the mount location of the holder to the tool changer station frame.

Table 6-2 ◆ Use Model in World selections

Modeling Adaptors Using Parameters

Toggling ◆ Use Parameters displays a list of available adaptor types: End Mill, Shell Mill and Shank Stub Arbor. Highlighting each displays a panel, described in the following sections.

Modeling an End Mill Tool Holder

Highlighting End Mill Adaptor from the list displayed by toggling ◆ Use Parameters displays the End Mill Adaptor panel.

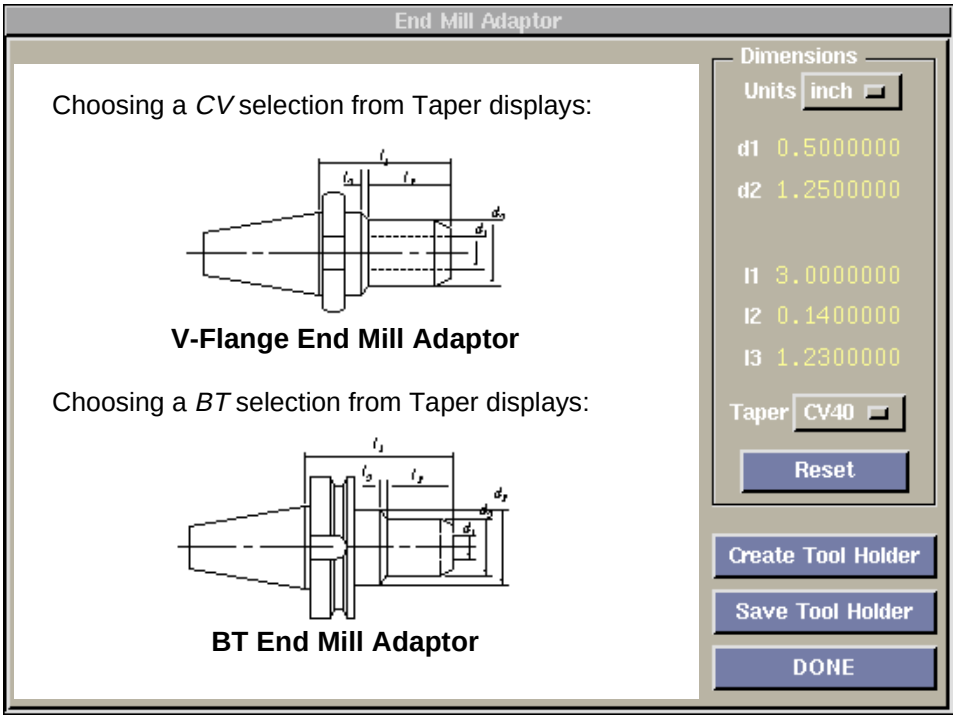


Figure 6-9 The End Mill Adaptor panel

The End Mill Adaptor panel contains these parameters for model tooling:

- d1 ID (internal diameter) of tool holder
- d2 OD (external diameter) of tool holder
- l1 Gauge length of holder

Units defines units used for d1, d2, l1, l2 and l3, choices are *inch* or *mm*.

Taper defines the adaptor type, choices are CV40, CV45, CV50 (V-flange adaptors) and BT35, BT40, BT45, BT50.

Modeling a Shell Mill Tool Holder

Highlighting Shell Mill Adaptor from the list displayed by toggling ◆ Use Parameters displays the Shell Mill Adaptor panel.

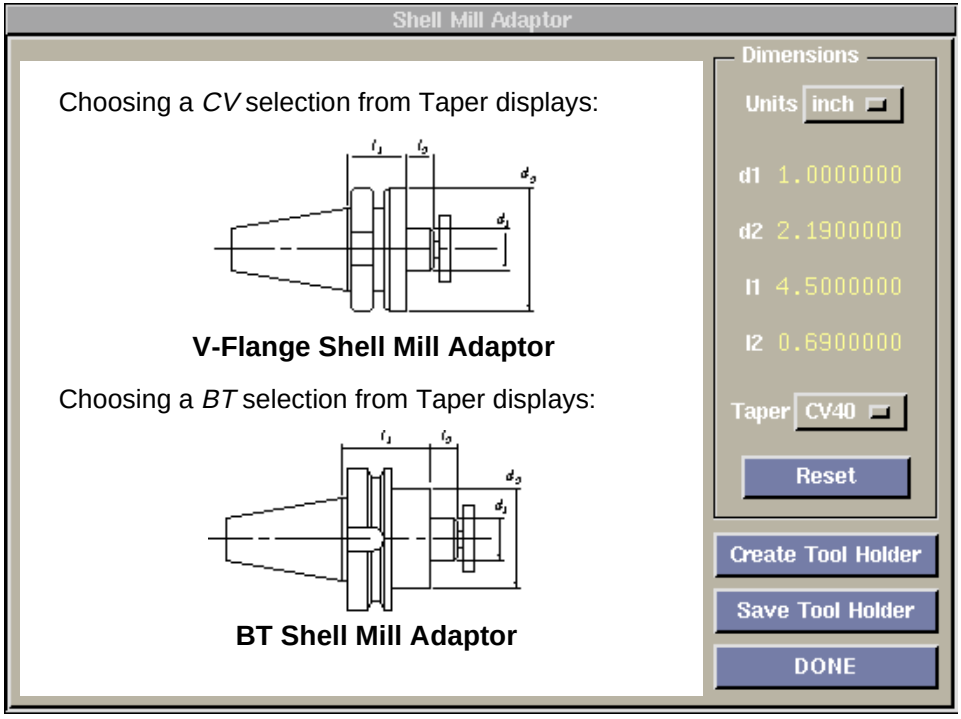


Figure 6-10 The Shell Mill Adaptor panel

The selections in the Shell Mill Adaptor panel are the same as the End Mill Adaptor panel selections, which are described in the previous section.

Modeling a Shank Stub Arbor

Highlighting Shank Stub Arbor from the list displayed by toggling ◆ Use Parameters displays the Shank Stub Arbor panel.

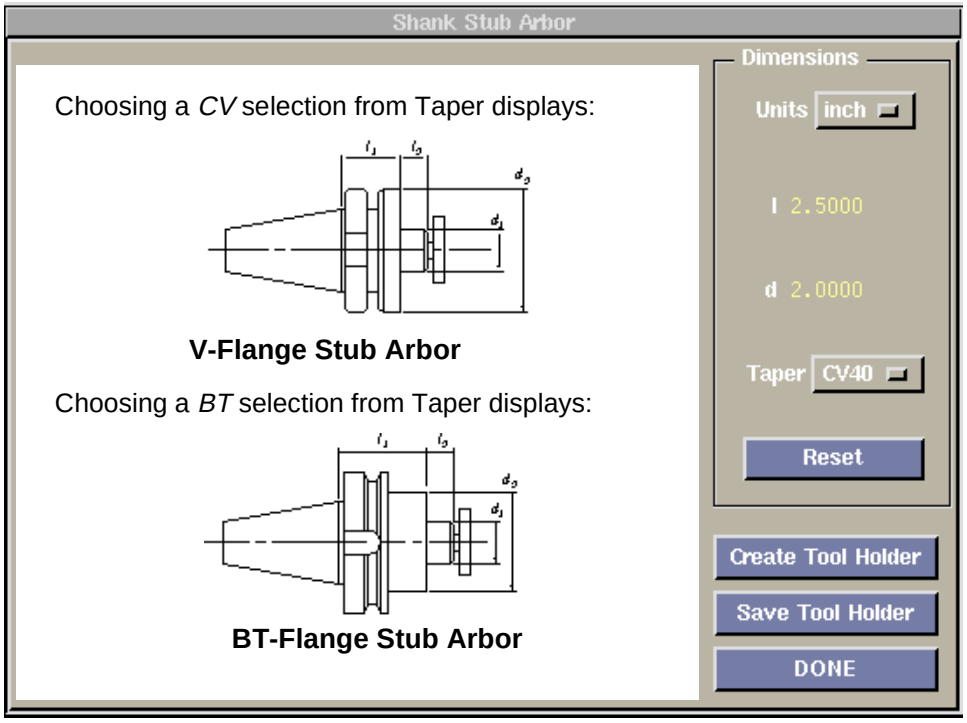


Figure 6-11 The Shank Stub Arbor panel

The End Mill Adaptor panel contains these parameters for model tooling:

- l — Gauge length of holder
- d — Diameter of tool holder

Units defines units used for l and d, choices are *inch* or *mm*.

Taper defines the adaptor type, choices are CV40, CV45, CV50 (V-flange arbors) and BT35, BT40, BT45, BT50.

Tool Changer

A **tool changer** is a device for changing cutters between machining operations. For a turning machine, a tool changer usually consists of a turret containing multiple cutter assemblies (see Figure 6-15, “Tool library for CNC turret lathe” on page 6-16). For a machining center, the tool changer is usually composed of a tool magazine, which stores the tool holder/cutter assemblies, and mechanisms (usually a mechanical arm) for exchanging cutter assemblies between the tool magazine and the machine spindle (Figure 6-12).

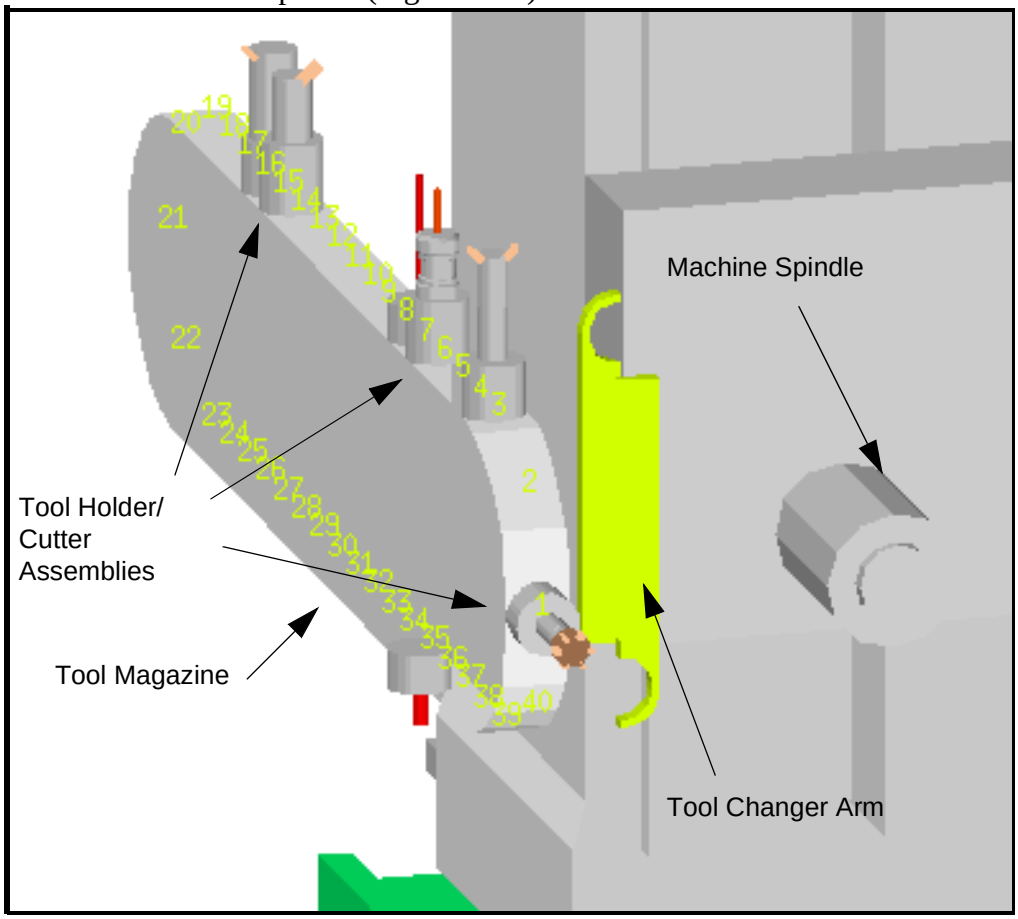


Figure 6-12 Tool changer for horizontal machining center

In Soft Machines, a tool changer can be an automatic tool changer for machining centers, or a multiple station turret on lathes and turning centers.

NOTE	Figure 6-1, “Tool library components” on page 6-1 illustrates how tool changers are used with other tooling components.

Toggling ◆ Tool Changer in the Tool Setup panel displays the selections for tool changers. Before a workcell object can be converted to a tool changer, frames designating station locations must be “taught” on the model.

NOTE	Teaching frames is explained in “Teaching Frames” on page 7-25.

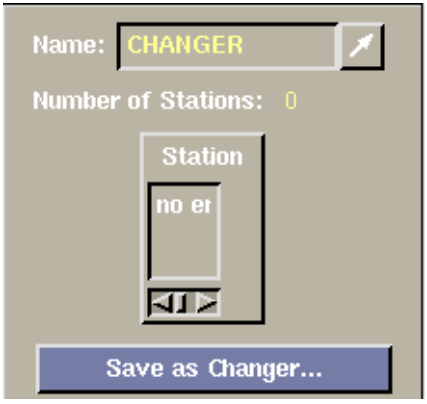


Figure 6-13 ◆ Tool Changer selections

Table 6-3 describes the tool changer selections.

Selection	Description
Name	Specifies the workcell object to be converted to a tool changer.
Number of Stations	Specifies the number of stations on the tool changer.

Table 6-3 ◆ Tool Changer selections

Selection	Description
Station	Selects the station number to be assigned to a frame. Station numbers are assigned by highlighting the station number in the panel and then selecting the frame from either the *Graphics Window* or *Quick Pick Window*.
Save As Changer…	Saves the model as a tool changer.

Table 6-3 ◆ Tool Changer selections (continued)

NOTE Each Soft Machines project area supplied by SILMA, Division of Adept Technology, Inc. contains a default tool changer located under the nc_tooling subdirectory.

Tool Library

A **tool library** is a collection of tool holder/cutter assemblies mounted on a tool changer. Different NC part programs require different combinations of tool holders and cutters. Tool libraries provide a means of storing these different combinations (see Figure 6-15, “Tool library for CNC turret lathe” on page 6-16).

Toggling ◆ Tool Library in the Tool Setup panel displays the selections for the tool library.

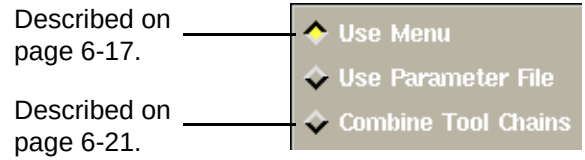


Figure 6-14 ◆ Tool Library selections

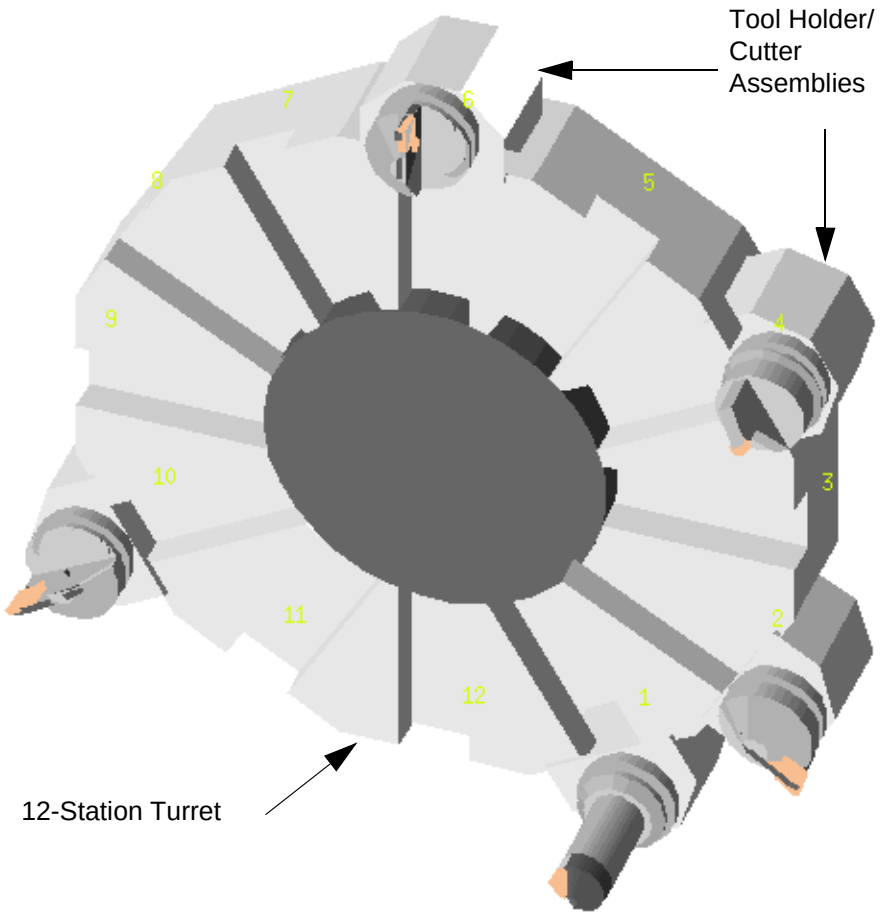


Figure 6-15 Tool library for CNC turret lathe

Using a Menu

Toggling ◆ Use Menu in the tool library selections displays the Tool Library panel.

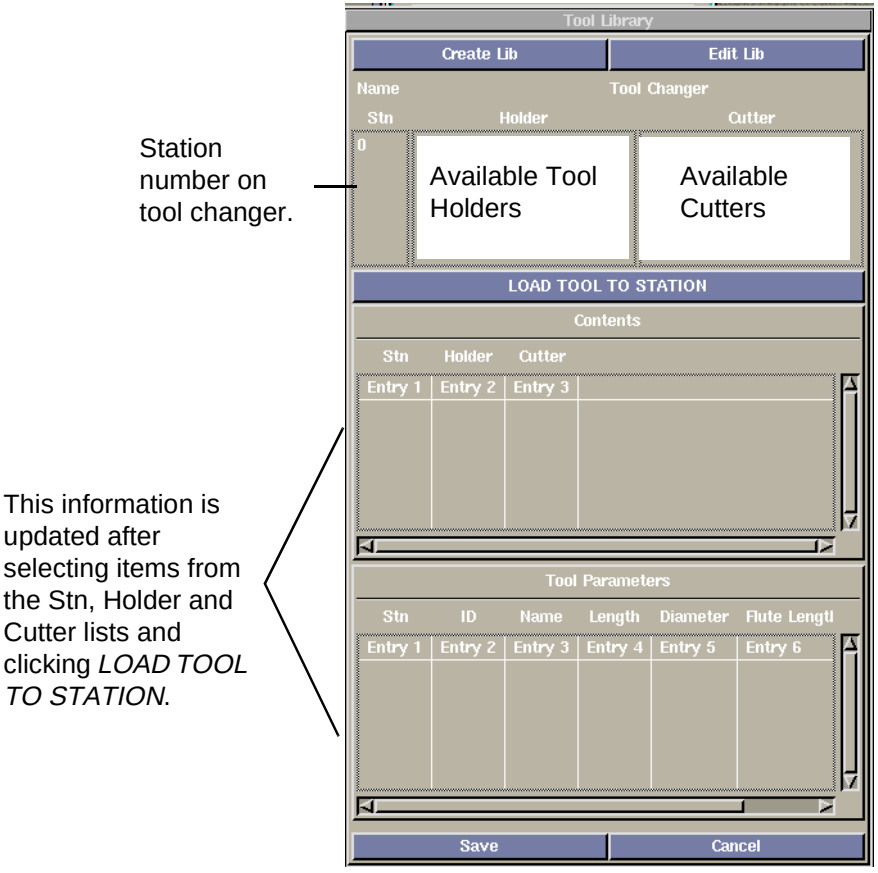


Figure 6-16 The Tool Library panel

Creating a Tool Library

Follow these steps to create a new library.

1. Select *Create Lib*. A name requestor is displayed.

Figure 6-17 Name requestor

2. Enter the filename you would like for the library and click *OK*. The Select Tool Changer panel is displayed.

Figure 6-18 The Select Tool Changer panel

3. Highlight a tool changer from the list and click *OK*. The tool changer is installed. The Select Tool Changer panel is dismissed.

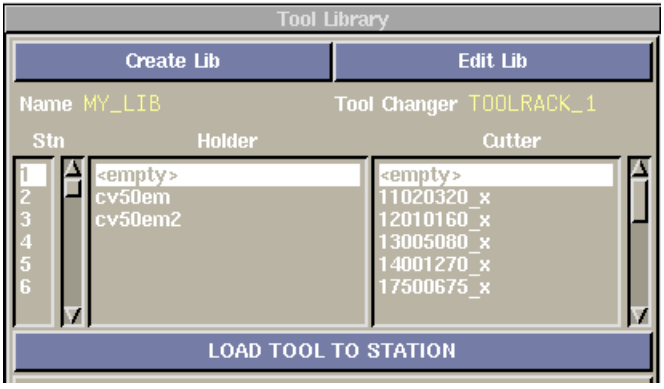


Figure 6-19 Installing a new library

4. Follow these steps to mount a holder and cutter onto a station.

a. Select a station from the Stn list.

b. Select an item from the Holder list and one from the Cutter list.

c. Click *LOAD TOOL TO STATION*. A name requestor is displayed.

d. Enter a new ID for the tool, or accept the default. The **tool ID** is the reference number called by the tool change command. The holder/cutter is mounted to the designated station on the tool changer.

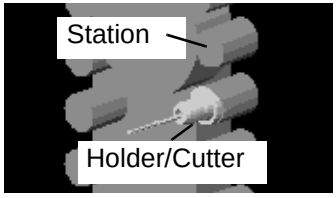


Figure 6-20 Mounting a holder/cutter

The Contents and Tool Parameters sections of the Tool Library panel are updated with the new information.

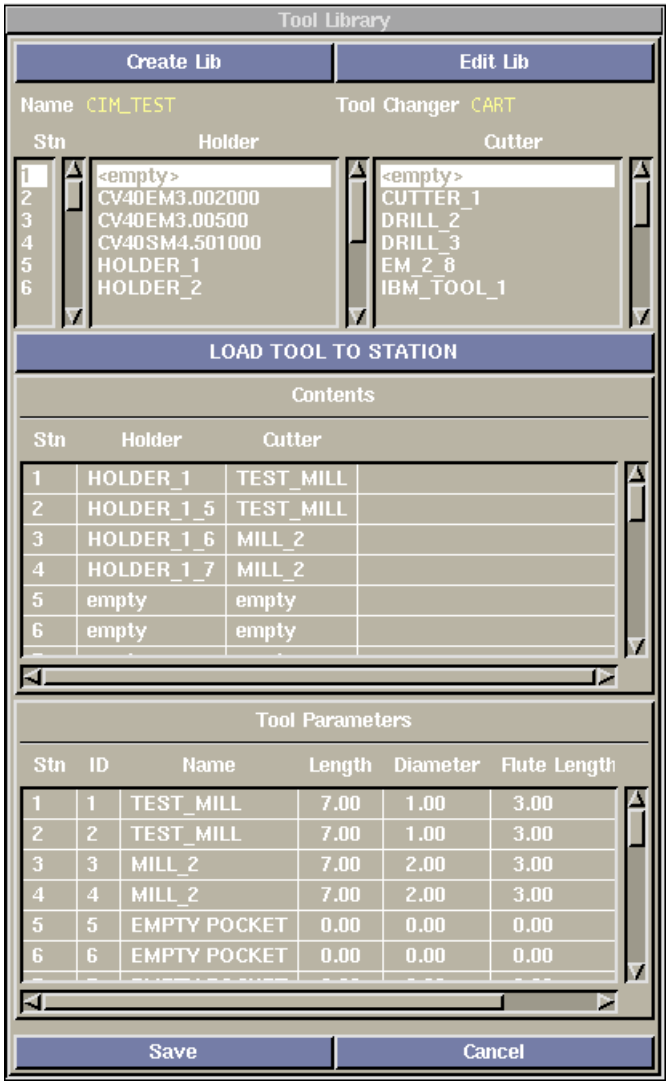
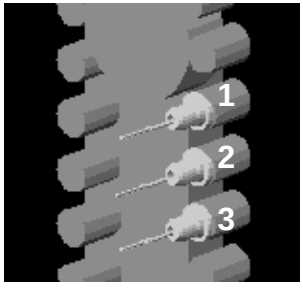


Figure 6-21 The updated Tool Library panel

Removing a Tool from a Station

Follow these steps to remove a tool from a station.

1. Select the station in the Stn field.
2. Select <empty> in the Holder and Cutter lists.
3. Click *LOAD TOOL TO STATION* to unload the holder/cutter.



Select 2 in the Stn field and <empty> in both the Holder and Cutter lists.

Click *LOAD TOOL TO STATION*.

The middle holder/cutter is removed.

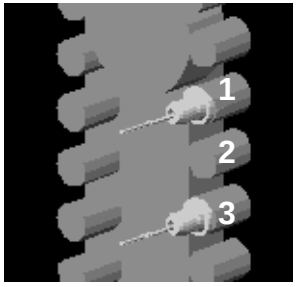


Figure 6-22 Removing a tool from a station

Multiple Tool Chains

Some machine tools have tool changers containing more than one tool chain.

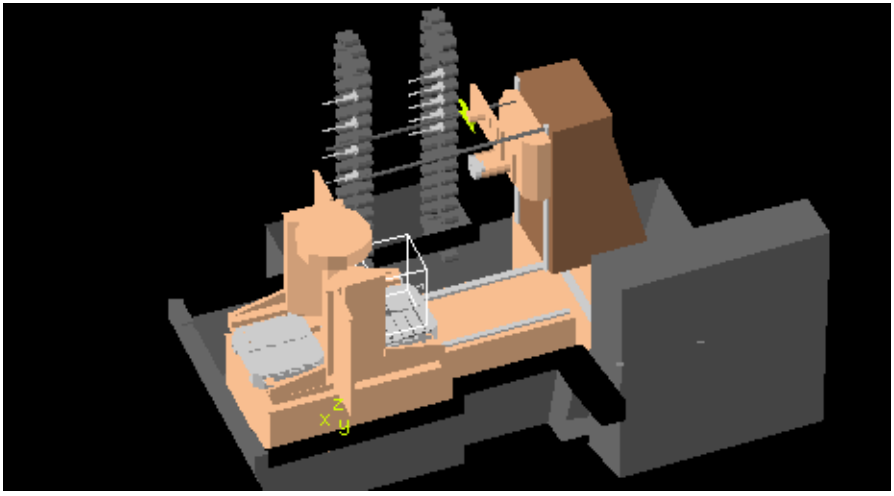


Figure 6-23 Multiple tool chains

In Soft Machines, tool changers with multiple tool chains are handled as follows:

- Load tools onto each tool chain and save it as a separate tool library.
- Use the ◆ Combine Tool Chains option to combine the individual tool chains to create a multiple tool chain library.

The ◆ Combine Tool Chains option is used to model tool libraries containing more than one tool chain, such as those found on machining centers with multiple tool chains.

In Soft Machines, tool libraries with multiple tool chains are modeled by combining the tool library for each tool chain.

Toggling ◆ Combine Tool Chains in the tool library selections displays the Combine Tool Chains panel.

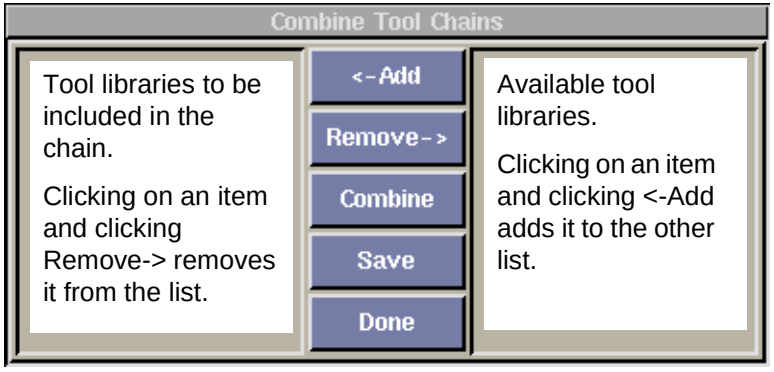

Combine Tool Chains
Tool libraries to be included in the chain.
Clicking on an item and clicking Remove-> removes it from the list.
<-Add
Remove->
Combine
Save
Done
Available tool libraries.
Clicking on an item and clicking <-Add adds it to the other list.

Figure 6-24 The Combine Tool Chains panel

Clicking *Combine* displays a name requestor. Enter the name you would like for the tool chain.

Chapter 7

Utilities

The **Utilities** pulldown menu contains utilities for detecting collisions that will occur in a simulation, creating movies, measuring distances between objects, modifying the way the factory is displayed, creating hard copy output, and obtaining access to your file system.

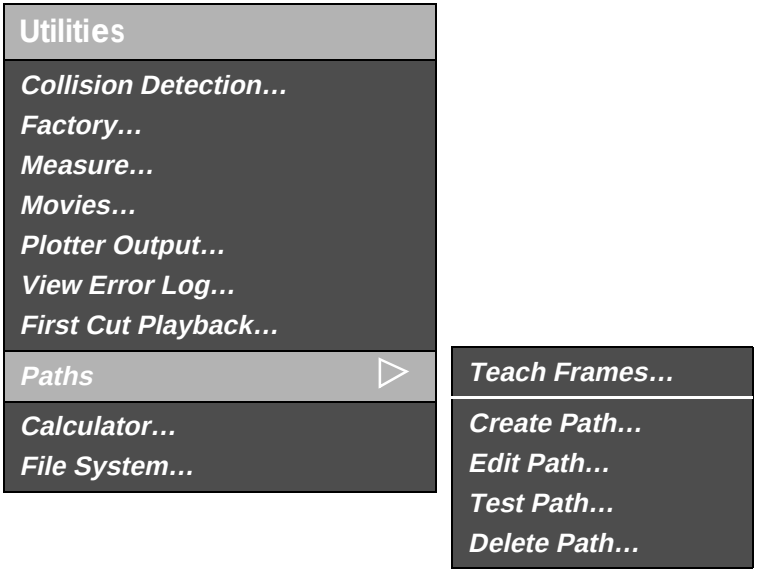


Figure 7-1 The **Utilities** menu

Selecting *Calculator…* displays a calculator containing commonly-used mathematical functions.

Tool Bar Shortcut Clicking this tool bar button displays the calculator.

Table 7-1 describes the selections available from the **Utilities** menu.

Selection	Description
Collision Detection…	See “Collision Detection” on page 7-3.
Factory…	See “The Factory” on page 7-12.
Measure…	See “Measuring” on page 7-15.

Table 7-1 **Utilities** selections

Selection	Description
Movies…	See “Movies” on page 7-17.
Plotter Output…	See “Creating Hard Copy Output” on page 7-21.
View Error Log…	Displays the *View Error Log Window*, which displays the error log associated with the selected file. See “Viewing an Error Log” on page 7-24.
First Cut Playback…	Displays a pop up box that is used to load a playback file. “Using Playback Mode” on page B-22 provides more information on viewing playback files.
Paths	See “Paths” on page 7-25.
File System…	See “Working with Files and Directories” on page 7-31.

Table 7-1 **Utilities** selections (continued)

Collision Detection

The Collision Detection panel is used to check workcell objects for collisions and near misses. The panel can be displayed by selecting *Collision Detection...* from the **Utilities** pulldown menu.

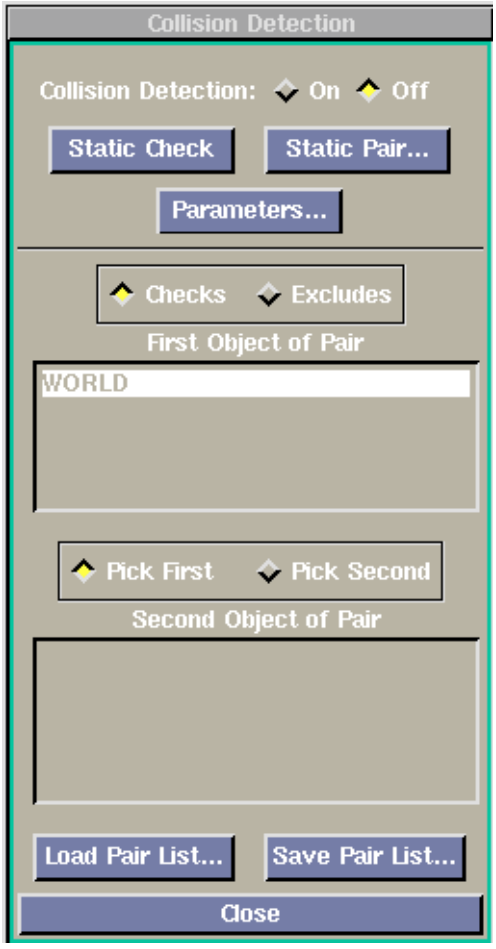


Figure 7-2 The Collision Detection panel

Tool Bar Shortcut Clicking this tool bar button displays the Collision Detection panel.

Table 7-2 describes the selections available from the Collision Detection panel.

Selection	Description
Collision Detection	Toggles the collision detection facility ◆ On or ◆ Off. **NOTE** The color used to highlight the collision in the *Graphics Window* is set in the Graphics Defaults panel (see page 4-9).
Static Check	Performs a static collision check. Static collision checks are used to determine which objects are colliding at the moment you select *Static Check*.
Static Pair…	Displays the Static Pair panel. The first object is displayed in the Object to Check with field. When you select the second object, Soft Machines performs a static check (see *Static Check* above).
Parameters…	Displays the Collision Parameters panel. See Figure 7-5, "The Collision Parameters panel" on page 7-8.
◆ Checks	Selects which collision pairs will be checked for collisions. See "Setting Up Collision Pairs" on page 7-5.
◆ Excludes	Selects which collision pairs will be excluded from collision checking.
◆ Pick First	Selects the object which will have other objects checked against it for collisions. See "Setting Up New Collision Pairs" on page 7-5.
◆ Pick Second	Selects the object or objects to be checked against the object in the First Object of Pair box. Clicking on an object in the *Quick Pick Window* causes the object to be listed in the Second Object of Pair box.
Load Pair List…	Displays the Load Pair Lists panel, which you can use load collision pairs that you saved previously. See Figure 7-3, "The Load Pair Lists panel" on page 7-7.

Table 7-2 Collision Detection selections

Selection	Description
Save Pair List…	Displays the Save Pair Lists panel, which you can use to save collision pairs. See Figure 7-4, "The Save Pair Lists panel" on page 7-7.

Table 7-2 Collision Detection selections (continued)

To use collision detection, you need to:

1. Toggle Collision Detection ◆ On.
2. Toggle ◆ Checks and select the pairs you want to be checked for collisions. See "Setting Up Collision Pairs" below.
3. Toggle ◆ Excludes and select those pairs that you do not want to be checked for collisions.
4. Set up the parameters. See "Setting Up Collision Parameters" on page 7-8.

Setting Up Collision Pairs

Collision pairs are used in collision detection.

Setting Up New Collision Pairs

You can use the ◆ Pick First and ◆ Pick Second toggle (in the Collision Detection panel) to set up collision pairs. You need to set up two sets of lists—one list of object pairs to check for collisions and one list to exclude from collision checking.

1. Toggle ◆ Checks.
2. Make sure ◆ Pick First is toggled. Click on an object in the *Quick Pick Window*. This causes the object to be listed in the First Object of Pair box and ◆ Pick Second to be toggled. Selecting WORLD causes the second object to be checked against all other objects. You may go back and toggle ◆ Pick First to pick new collision pairs.

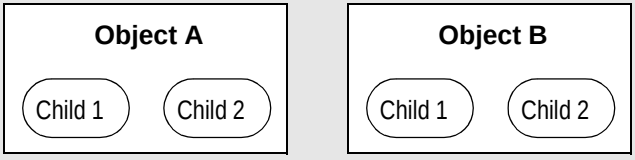
3. Select the object (or objects) to be checked against the object in the First Object of Pair box. Clicking on an object in the *Quick Pick Window* lists it in the Second Object of Pair box.
4. Click *Save Pair List...* and use the Save Pair Lists panel to save collision pairs.

The object pairs that will be checked for collisions are now selected.

5. Toggle ◆ Excludes and set up the object pairs to be excluded from collision checking.

Example

Starting out with Object A and Object B



If you wanted to check if Object A collides with Object B, but you don't want to check if Child 1A collides with Child 1B, you would:

Toggle ◆ Checks and set up Object A and Object B as a collision pair.

Toggle ◆ Excludes and set up Child 1A and Child 1B as an exclude pair.

Loading Collision Pairs

The Load Pair Lists panel is used to load collision pairs that have been previously saved. Clicking *Load Pair List...* the Collision Detection panel displays the Load Pair Lists panel.

Load Pair Lists
Select Pair List File To Load
List of previously saved pair lists.
File Name:
Load
Cancel
This field can be used to enter the filename of an existing collision pair.

Figure 7-3 The Load Pair Lists panel

Saving Collision Pairs

The Save Pair Lists panel is used to assign a filename to a defined collision pair. Clicking *Save Pair List...* in the Collision Detection panel displays the Save Pair Lists panel.

Save Pair Lists
Select Pair List File To Save
List of defined pair lists.
File Name:
Save
Cancel
Specifies the filename that will be used for the selected collision pair.

Figure 7-4 The Save Pair Lists panel

Setting Up Collision Parameters

The Collision Parameters panel is used to set up the conditions and options for checking collisions. Clicking *Parameters...* from the Collision Detection panel displays the Collision Parameters panel.

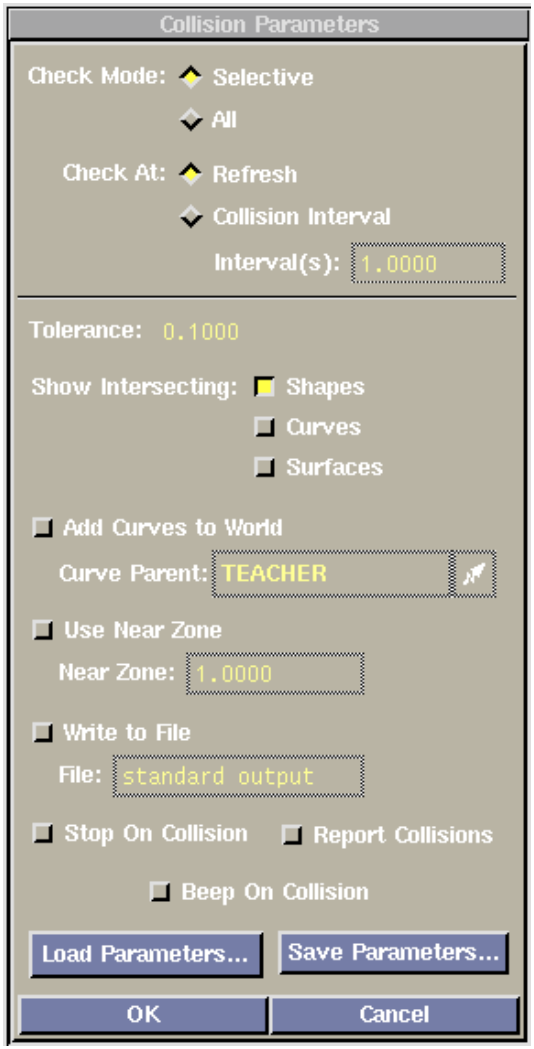


Figure 7-5 The Collision Parameters panel

The selections available from the Collision Parameters panel are described in the following sections.

Check Mode

◆ Selective — Checks selected objects against one another for collisions. Use the Checks/Excludes toggle in the Collision Detection panel to add objects to and remove objects from this list.

◆ All — Checks all workcell objects against one another for collisions.

Check At

Sets the interval that objects will be checked for collisions.

◆ Refresh — Collisions will be checked when the *Graphics Window* is refreshed.

NOTE You can change the update rate in the Graphics Defaults panel. See "Setting the Update Rate" on page 4-10.

◆ Collision Interval — Collisions will be checked at the interval specified in the Interval(s) field.

Tolerance

Displays the current value of the tolerance zone (in current distance units). **Tolerance** is the distance that Soft Machines uses to determine whether or not a collision has occurred. For instance, if Tolerance is set to 0.1 (and the current workcell units is centimeters), then Soft Machines will consider objects that come within .1 centimeters of one another to be colliding.

Show Intersecting

❑ Shapes — Highlights colliding shapes.

❑ Curves — Highlights colliding curves.

❑ Surfaces — Highlights colliding surfaces.

NOTE The color used to highlight the colliding surfaces in the *Graphics Window* is set in the Graphics Defaults panel (see page 4-9).

❏ Add Curves to World

Adds curves created from collisions as shapes to the World. The Curve Parent shape selector is used to specify the shape under which collision curves are added.

❏ Use Near Zone

Checks for near misses. The Near Zone field sets the current value of the near zone (in current distance units).

The **near zone** is the distance used to determine whether or not a near miss has occurred. For instance, if Near Zone is set to .1 (and the current workcell units is centimeters), then Soft Machines will consider objects that come within .1 centimeters of one another to be nearly missing each other.

NOTE The color used to highlight the near miss in the *Graphics Window* is set in the Graphics Defaults panel (see page 4-9).

❏ Write to File

Writes collision information to the file specified in the File field.

❏ Stop on Collision

Pauses the simulation when a collision is detected.

❏ Report Collisions

Prints collision information in the shell window containing the SIL> prompt. This is the same window you used to start Soft Machines.

❏ Beep on Collision

Beeps when a collision is detected.

Once you have set up the parameters for your current workcell, you can save and load this configuration in future sessions of Soft Machines by using *Load Parameters...* and *Save Parameters...*.

Load Parameters…

Displays the Load Parameters panel, which is used to load a configuration that was previously saved.

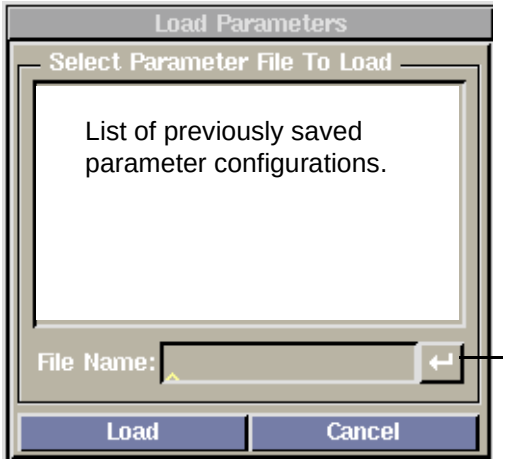

Load Parameters
Select Parameter File To Load
List of previously saved parameter configurations.
File Name:
Load
Cancel
This field can be used to enter the filename of an existing configuration.

Figure 7-6 The Load Parameters panel

Save Parameters…

Displays the Save Parameters panel, which is used to save your configuration.

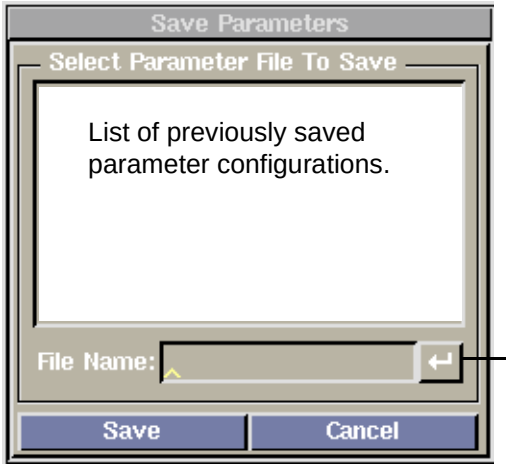

Save Parameters
Select Parameter File To Save
List of previously saved parameter configurations.
File Name:
Save
Cancel
Specifies the filename that will be used for the selected configuration.

Figure 7-7 The Save Parameters panel

The Factory

The **factory** is the background setting for your workcell objects. When you first start Soft Machines, the factory has grid lines on the floor and displays walls. You can change this display by using the Factory panel. Selecting *Factory...* from the **Utilities** pulldown menu displays the Factory panel.

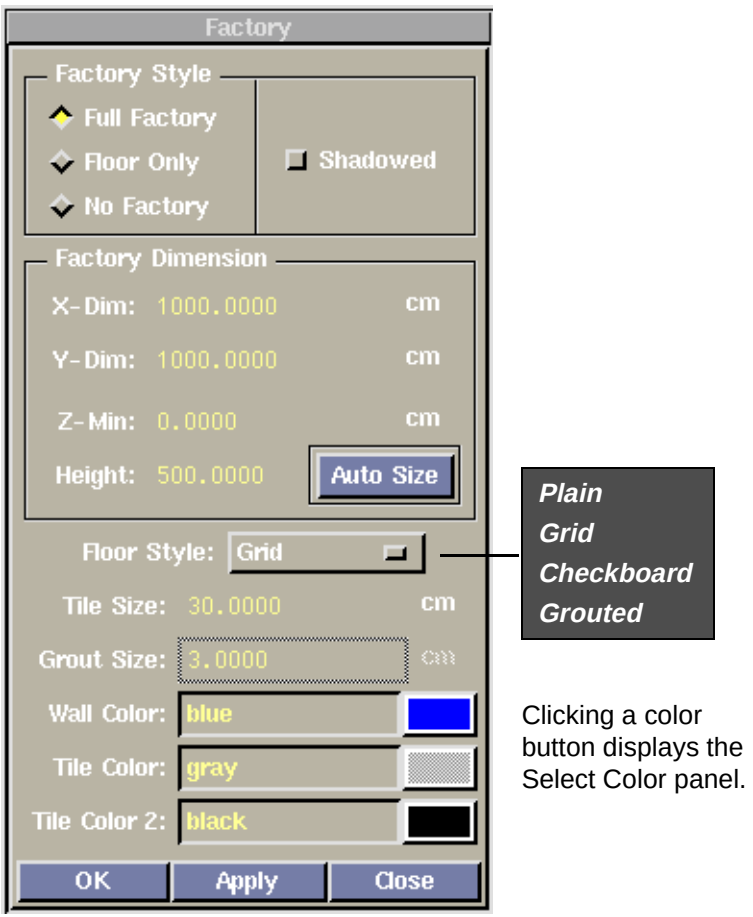
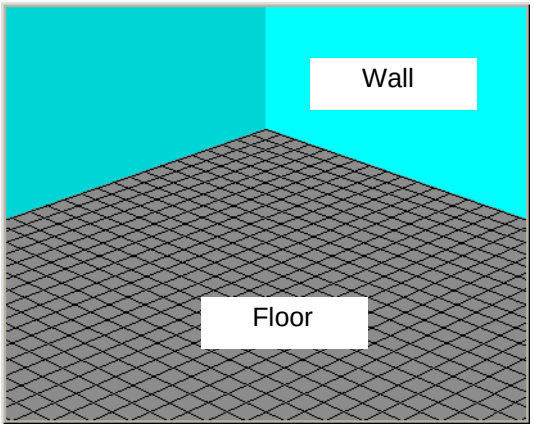


Figure 7-8 The Factory panel

Displaying the Factory

The selections in the Factory Style box control which parts of the factory are displayed.



- ◆ Full Factory
  Displays the walls and floor.
- ◆ Floor Only
  Removes the walls from the display.
- ◆ No Factory
  Removes the walls and the floor from the display.

Figure 7-9 The factory

❑ Shadowed Casts shadows on the floor. Although the effect is more dimensional, this selection causes the system to slow down.

Setting the Size

The selections in the Factory Dimensions box set the wall and floor dimensions.

X-Dim and Y-Dim set the dimensions of the floor.

Height sets the height of the walls.

Auto Size resizes the factory to the minimum size that includes all installed objects.

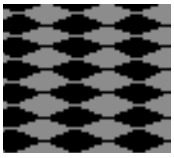
Display Options

Wall Color specifies the color of the walls.

Floor Style sets how the workcell floor looks:

Plain Removes grid lines or tiles and displays the floor in a solid color. The color is set by the Tile Color color button.

Grid Displays a solid color floor with lines marking a grid. The color of the floor is set by the Tile Color color button. The color of the grid lines is set by the Tile Color 2 color button. The space between the grid lines is set with the Tile Size field. This is the default setting. A grid floor is shown in Figure 7-9, “The factory” on page 7-13.

Checkboard  Fills in every other tile of the grid floor. The tile colors are set by the Tile Color and Tile Color 2 color buttons. The size of the squares is set with the Tile Size field.

Grouted Displays separate tiles with grouting in between the tiles. The color of the tiles is set by the Tile Color color button. The size of the tiles is set with the Tile Size field. The color of the grout is set by the Tile Color 2 color button. The thickness of the grouting is set with the Grout Size field.

Measuring

The Measure panel provides a way to measure distances in the *Graphics Window*. Click on the items you want to measure using the mouse, and the distance between them is reported in the Measure Data panel. The panels can be displayed by selecting *Measure...* from the **Utilities** pulldown menu.

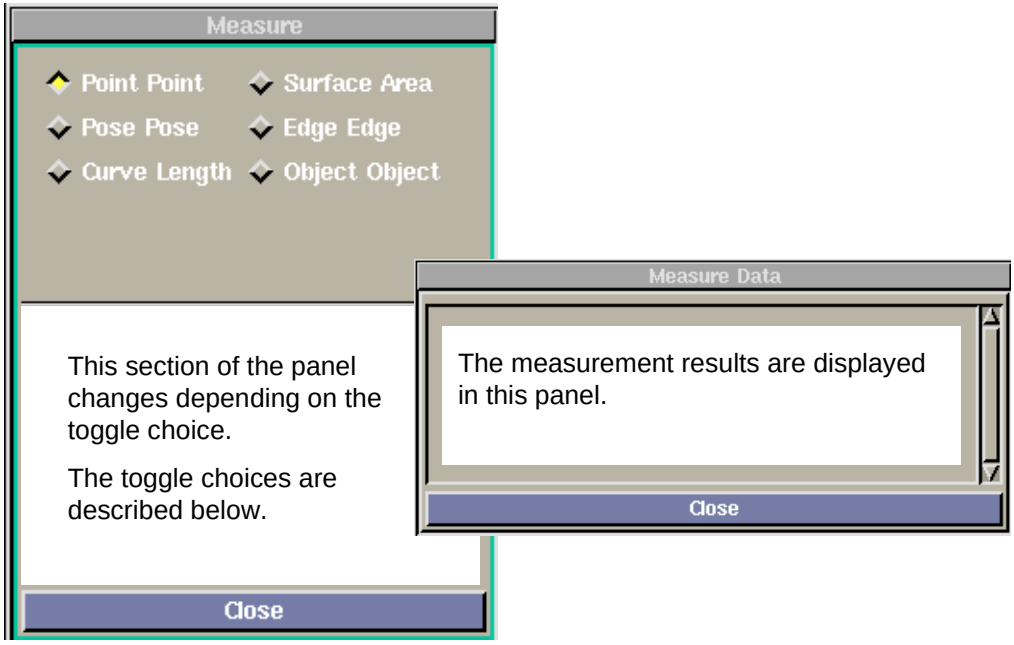


Figure 7-10 The Measure and Measure Data panels

Tool Bar Shortcut Clicking this tool bar button displays the Measure panel.

The selections available from the Measure panel are described in Table 7-3.

Selection	Description
◆ Point Point	Measures the distance between two selected points. The Pick Mode toggle choices restrict the type of points that you are measuring. For example, if you select a pair of points with ◆ Edge toggled, the edges closest to the points you selected are chosen.
◆ Surface Area	Measures the surface area of an object by adding the areas of its facets. Click on a surface.
◆ Pose Pose	Measures the distance between two selected reference poses. Use the Measure from shape selector to select the first pose. When you select second pose, the result is displayed in the Measure Data panel.
◆ Edge Edge	Measures the distance between two selected edges. Click on a pair of edges.
◆ Curve Length	Measures the length of a curve by adding the length of its segments. Click on a curve.
◆ Object Object	Measures the distance between two selected objects. Use the Measure from shape selector to select the first object. When you select the second object, the result is displayed in the Measure Data panel.

Table 7-3 Measure selections

Movies

A **movie** is an animation created by recording an application (either by running the programs or by running the simulation). The Movies panel enables you to show pre-recorded movies using Soft Machines. The Movies panel can be displayed by selecting *Movies...* from the **Utilities** pulldown menu.

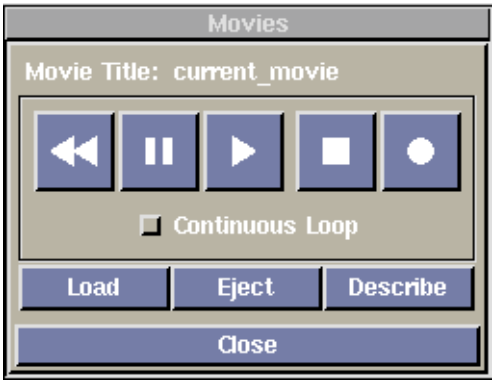


Figure 7-11 The Movies panel

Tool Bar Shortcut Clicking this tool bar button displays the Movies panel.

The buttons on the Movies panel have these uses:

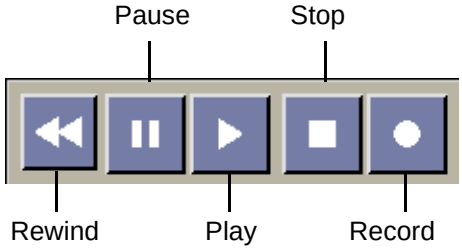


Figure 7-12 The Movies panel buttons

Switching on ❑ Continuous Loop will continue to play the selected movie or movies until switched off.

You can step through a movie one frame at a time by pausing the movie using the Pause button, then clicking the Play button.

The Load Movies panel is displayed by selecting *Load* from the Movies panel.

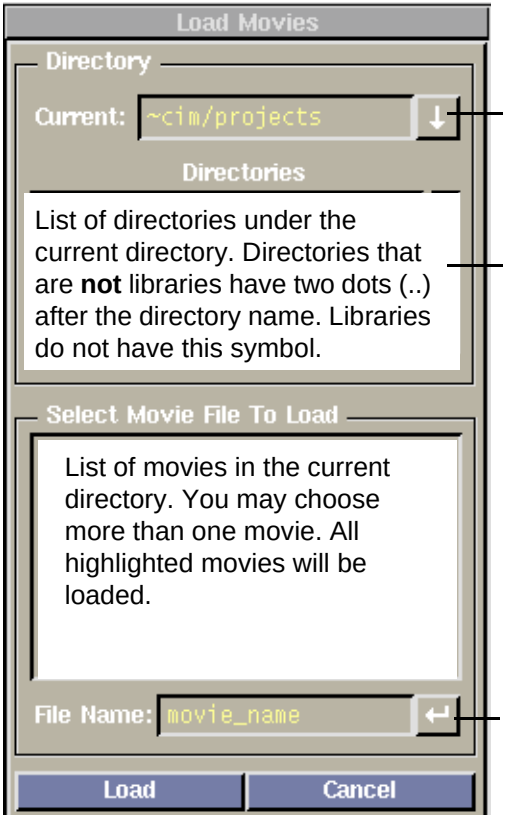

Load Movies
Directory
Current: ~cim/projects
Directories
List of directories under the current directory. Directories that are **not** libraries have two dots (..) after the directory name. Libraries do not have this symbol.
Select Movie File To Load
List of movies in the current directory. You may choose more than one movie. All highlighted movies will be loaded.
File Name: movie_name
Load
Cancel
Sets the directory. You can use the list button to select ~cim/projects or ~cim/users, or use the field to enter any directory on the system. See "Libraries" on page 1-23.
Selecting a directory from this list makes it the current directory.
Can be used to enter the filename of an existing movie.

Figure 7-13 The Load Movies panel

Selecting a movie and clicking *Load* dismisses the Load Movies panel and changes the Movies panel so the Play button is highlighted.

The Movie Information panel is used to obtain or edit a description of the current movie. Clicking *Describe* displays the Movie Information panel.

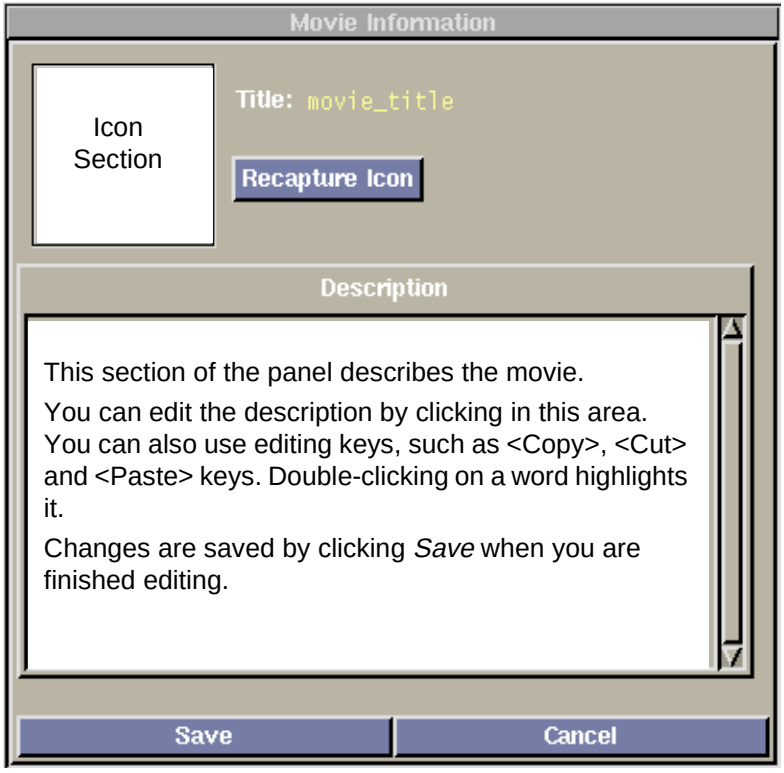

Movie Information
Icon Section
Title: movie_title
Recapture Icon
Description
This section of the panel describes the movie.
You can edit the description by clicking in this area. You can also use editing keys, such as <Copy>, <Cut> and <Paste> keys. Double-clicking on a word highlights it.
Changes are saved by clicking Save when you are finished editing.
Save
Cancel

Figure 7-14 The Movie Information panel

Clicking *Recapture Icon* takes a snapshot of the current *Graphics Window* and puts it in the icon section.

The Record Movies panel is displayed by selecting the Record button from the Movies panel.

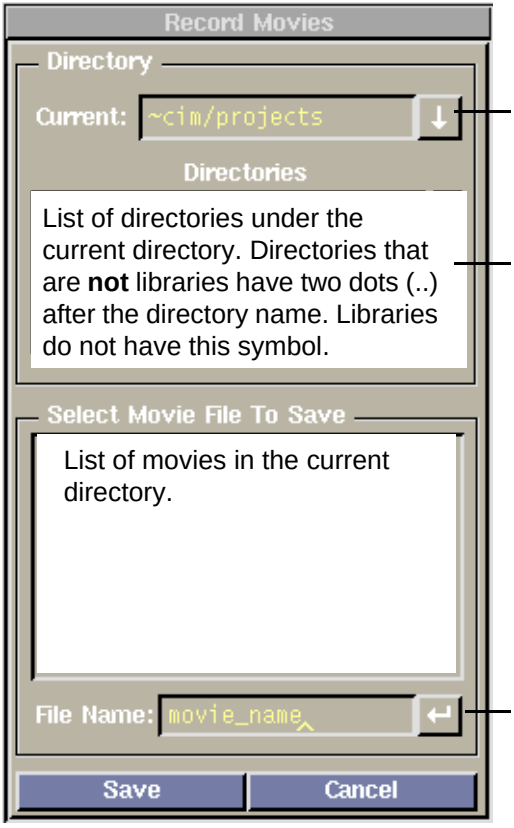

Record Movies
Directory
Current:
~cim/projects
Directories
List of directories under the current directory. Directories that are not libraries have two dots (..) after the directory name. Libraries do not have this symbol.
Select Movie File To Save
List of movies in the current directory.
File Name:
movie_name
Save
Cancel
Sets the directory. You can use the list button to select ~cim/projects or ~cim/users, or use the field to enter any directory on the system. See “Libraries” on page 1-23.
Selecting a directory from this list makes it the current directory.
Specifies the filename that will be used to store the movie.

Figure 7-15 The Record Movies panel

To record a movie, follow these steps:

1. Display the Record Movies panel by selecting the Record button from the Movies panel.
2. Enter the name of the movie.
3. Perform the actions in the movie.
4. Stop recording the movie by clicking the Stop button.

Although you can record a movie by following the preceding steps, you should record simulations by switching on ❑ Record Movie in either the Simulation Setup panel or the Set Job Parameters panel.

Creating Hard Copy Output

The Plotter Output panel enables you to create hard copy outputs of the current workcell. You can select page size, margins, output type, and type of printer to use when creating the output file. The Plotter Output panel can be displayed by selecting *Plotter Output...* from the **Utilities** pulldown menu.

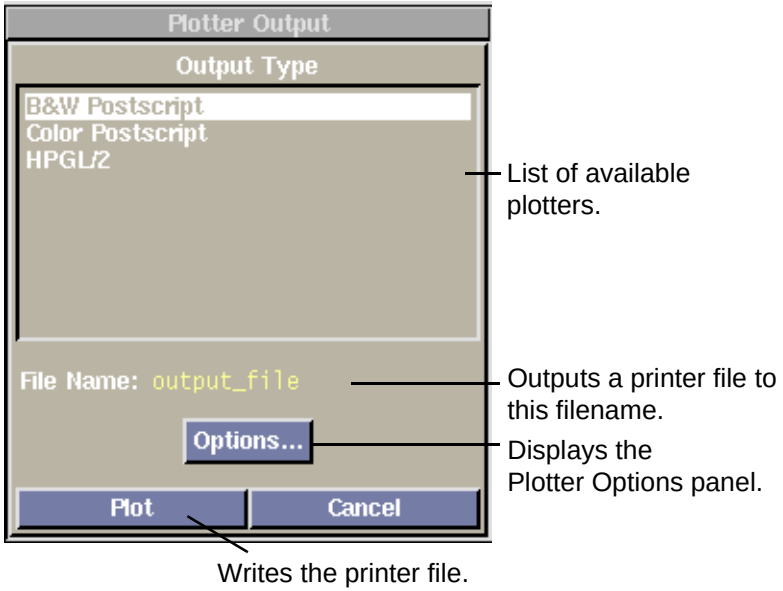


Figure 7-16 The Plotter Output panel

Highlighting a plotter in the Output Type list and clicking *Plot* writes a files readable by the selected printer.

The File Name field is used to specify a filename that will be used to store the output. Clicking *Plot* creates a printer file and saves it using the filename specified in the File Name field. Soft Machines will append an

extension onto the file and save the output. The extension depends on the plotter type: **.bwps** (black and white PostScript), **.clps** (color PostScript), or **.hpgl** (HPGL/2).

The printer file will be placed in the data subdirectory of the current library. To print this file, you will need to send it to your printer via your printer mechanism (lp, lpr, etc.).

Clicking *Options...* from the Plotter Output panel displays the Plotter Options panel.

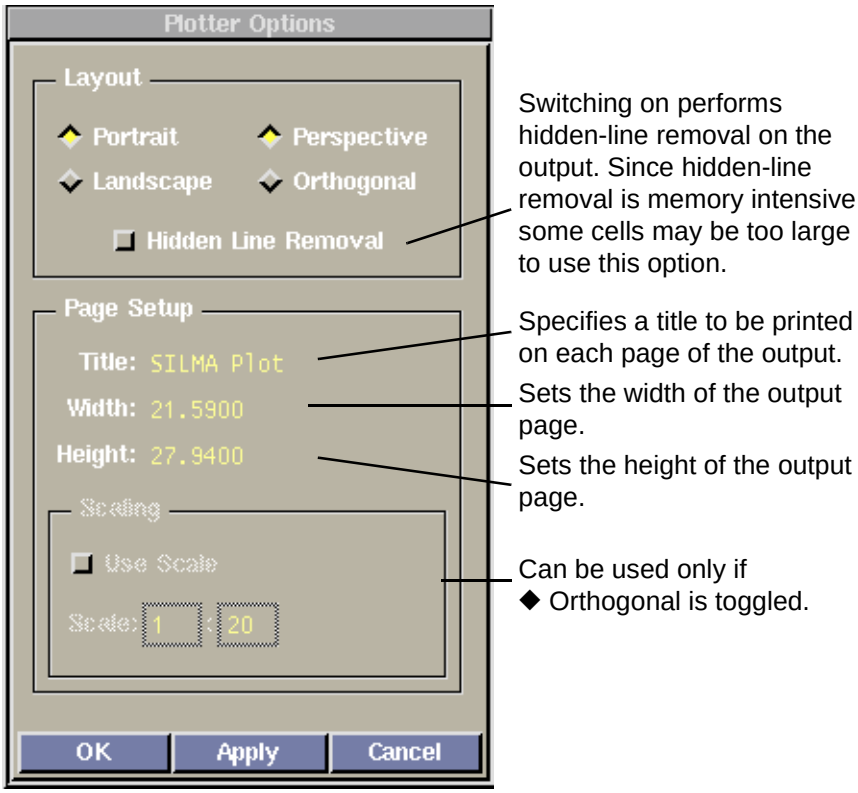

Plotter Options
Layout
Portrait
Perspective
Landscape
Orthogonal
Hidden Line Removal
Page Setup
Title: SILMA Plot
Width: 21.5900
Height: 27.9400
Scaling
Use Scale
Scale: 1 20
OK
Apply
Cancel
Switching on performs hidden-line removal on the output. Since hidden-line removal is memory intensive, some cells may be too large to use this option.
Specifies a title to be printed on each page of the output.
Sets the width of the output page.
Sets the height of the output page.
Can be used only if ◆ Orthogonal is toggled.

Figure 7-17 The Plotter Options panel

The Portrait/Landscape toggle selects the direction of print: ◆ Portrait is the normal print direction, while ◆ Landscape does a ninety degree rotation.

The Perspective/Orthogonal toggle sets how the image will be printed on the page:

◆ Perspective prints by doing a perspective projection of the three-dimensional world onto the two-dimensional page.

NOTE	No scale is printed in this mode because a fixed length will appear longer when it is close and shorter when it is far away. This makes scaled measurements impossible.

◆ Orthogonal prints by doing an orthogonal projection of the three-dimensional world. Scaling is enabled in this mode because a line will display with the same length, no matter how far away from the eye it is.

When using ◆ Orthogonal mode, the scale factor that best fits the page size is automatically determined. Switching on ❑ Use Scale will use the Scale setting. Entering a scale of 1:20 means that a centimeter measured on the printed page equals 20 centimeters in the real world.

Viewing an Error Log

The *View Error Log Window* displays the error log associated with the selected file. Selecting *View Error Log...* from the **Utilities** pulldown menu displays the *View Error Log Window*.

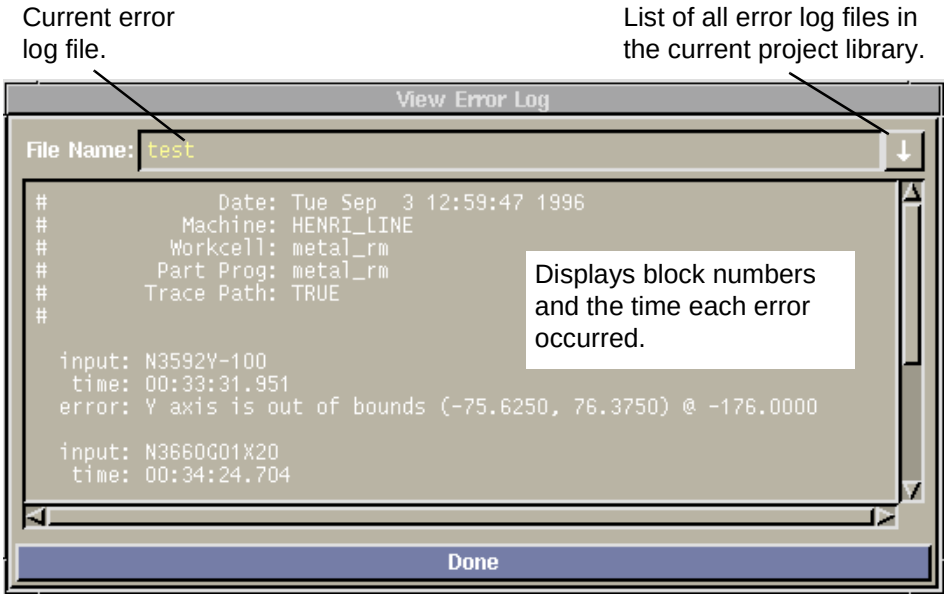

Current error log file.
List of all error log files in the current project library.
View Error Log
File Name: test
Date: Tue Sep 3 12:59:47 1996
Machine: HENRI_LINE
Workcell: metal_rm
Part Prog: metal_rm
Trace Path: TRUE
#
input: N3592Y-100
time: 00:33:31.951
error: Y axis is out of bounds (-75.6250, 76.3750) @ -176.0000
input: N3660G01X20
time: 00:34:24.704
Displays block numbers and the time each error occurred.
Done

Figure 7-18 The *View Error Log Window*

Paths

Teaching Frames

The Teach Frames panel is used to add new frames to the World. Selecting *Teach Frames...* from *Paths* selections in the **Utilities** pulldown menu displays the Teach Frames panel.

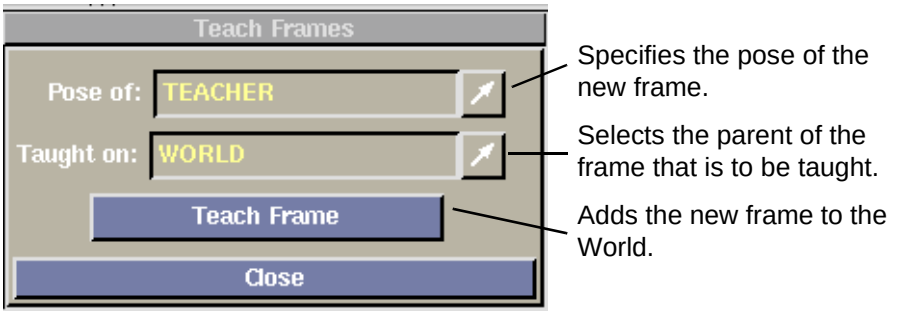


Figure 7-19 The Teach Frames panel

If that parent selected in Taught on has no frames underneath it, a subtree "frames" will appear underneath the parent in the *Quick Pick Window*, and new frames will become children of this "frames" parent.

Creating a Path

The Create Path panel is used to add a new path to the World. Selecting *Create Path...* from the *Paths* selections in the **Utilities** pulldown menu displays the Create Path panel**.**

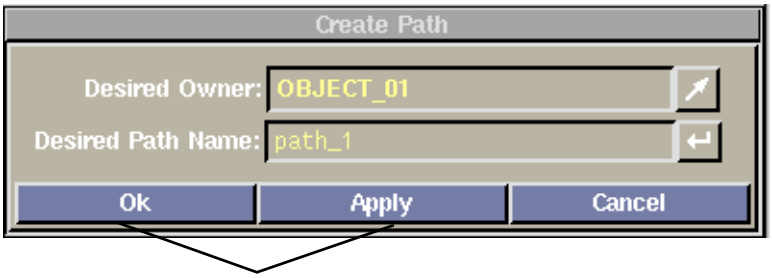


Figure 7-20 The Create Path panel

Desired Owner specifies the **owner** of the path (the workcell object that will move along the path).

Desired Path Name specifies the name the path will have. The path is created when *OK* or *Apply* is clicked.

Editing a Path

The Edit Path panel is used to add vias to a path and to manipulate these vias. Selecting *Edit Path...* from the *Paths* selections in the **Utilities** pulldown menu displays the Edit Path panel.

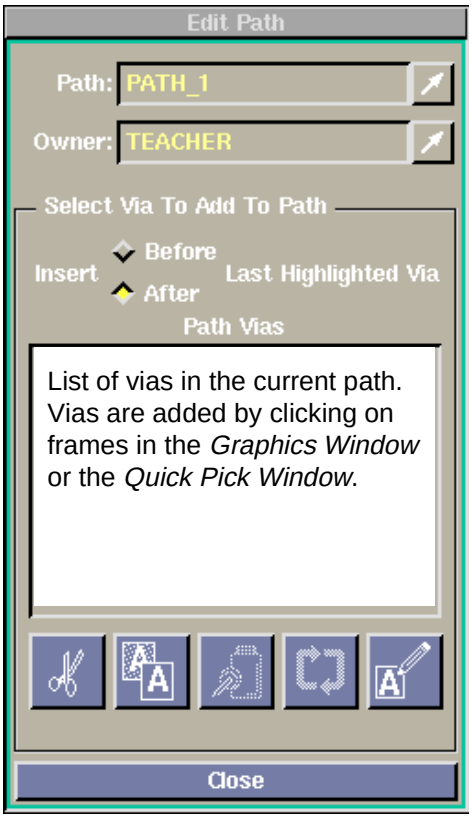


Figure 7-21 The Edit Path panel

Table 7-4 describes the selections available from the Edit Path panel.

Selection	Description
Path	Specifies which path is being edited.
Owner	Changes the owner of the path (the workcell object that will move along the path).

Table 7-4 Edit Path selections

Selection	Description
Select Via to Add to Path	Vias are added by clicking on frames in either the *Graphics Window* or the *Quick Pick Window*. While this panel is displayed, vias will be added to the Path Vias list. The toggle is used to control whether vias are added ◆ Before or ◆ After the current via.
	The Cut Vias button cuts the highlighted via(s). The cut vias can then be pasted using the Paste Vias button.
	The Copy Vias button copies the highlighted vias(s). The copied vias can then be pasted using the Paste Vias button.
	The Paste Vias button pastes via(s) that had been previously copied or cut. The ◆ Before/◆ After toggle controls where the vias will be pasted.
	The Reverse Vias button reverses the order of all highlighted vias. These vias need not be contiguous.
	The Edit Vias button enables you to edit the vias.

Table 7-4 Edit Path selections (continued)

Testing the Path

Before using the Test Path panel, you need to define a path (with at least one via) by doing the following:

- Teach frames.
- Create a path by using the Create Path panel.
- Add vias to the path by picking frames or joint vectors by using the Edit Path panel.

After defining a path, you can use the Test Path panel to test it. Selecting *Test Path...* from the *Paths* selections in the **Utilities** pulldown menu displays the Test Path panel.

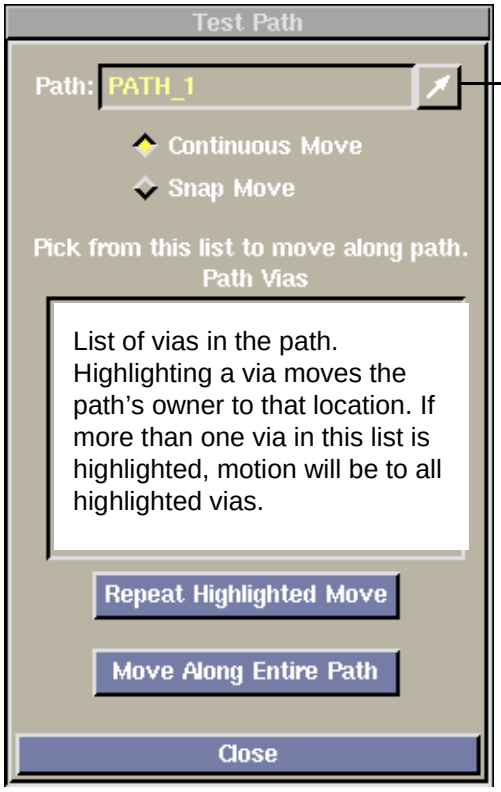

Test Path
Path: PATH_1
Specifies which path will be affected.
Continuous Move
Snap Move
Pick from this list to move along path.
Path Vias
List of vias in the path. Highlighting a via moves the path's owner to that location. If more than one via in this list is highlighted, motion will be to all highlighted vias.
Repeat Highlighted Move
Move Along Entire Path
Close

Figure 7-22 The Test Path panel

The machine can move in either of two modes, continuous move or snap move. The toggle choice controls which mode is used.

Toggling ◆ Continuous Move moves the machine along the selected range path from start to finish, calculating movement time.

Toggling ◆ Snap Move snaps the machine directly to the final location, calculating the time it would have taken to move along the path. This mode is useful when the range path cycle time is desired, but it is not necessary to see the device move along the path.

Highlighting a via in the path will move the path's owner to that location. If more than one via in the Path Vias list is highlighted, motion will be to all highlighted vias. This motion may be viewed again by clicking *Repeat Highlighted Move*.

Move Along Entire Path moves the path's owner along the complete path. The same behavior would happen if the entire path were highlighted and *Repeat Highlighted Move* was selected.

Deleting a Path

The Delete Path panel is used to delete paths from the World. Selecting *Delete Path...* from the *Paths* selections in the **Utilities** pulldown menu displays the Delete Path panel.

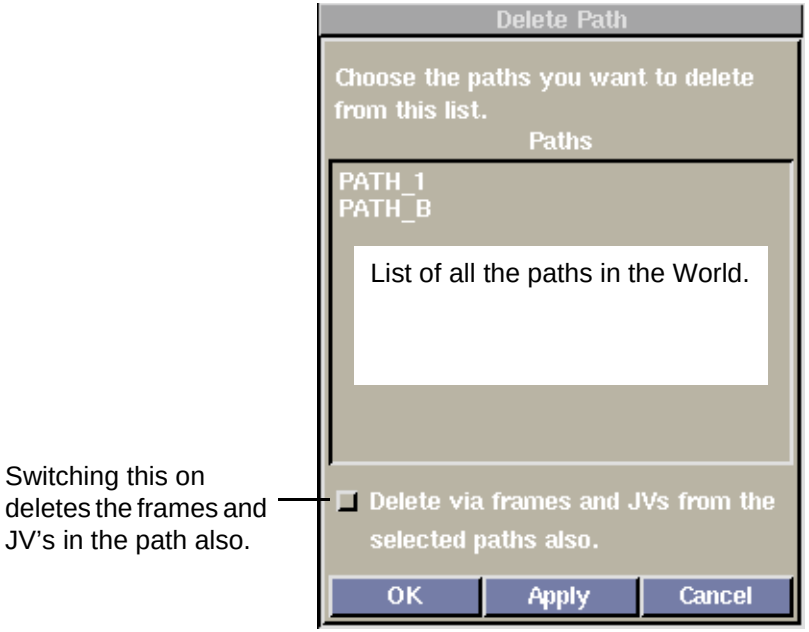

Delete Path
Choose the paths you want to delete from this list.
Paths
PATH_1
PATH_B
List of all the paths in the World.
Switching this on deletes the frames and JV's in the path also.
Delete via frames and JVs from the selected paths also.
OK
Apply
Cancel

Figure 7-23 The Delete Path panel

A path is deleted by highlighting it in the list and clicking *OK* or *Apply*.

Working with Files and Directories

The File System panel provides access to your machine's file system. Using this panel, you can manipulate files, directories and links without quitting Soft Machines. Selecting *File System...* from the **Utilities** pulldown menu displays the File System panel.

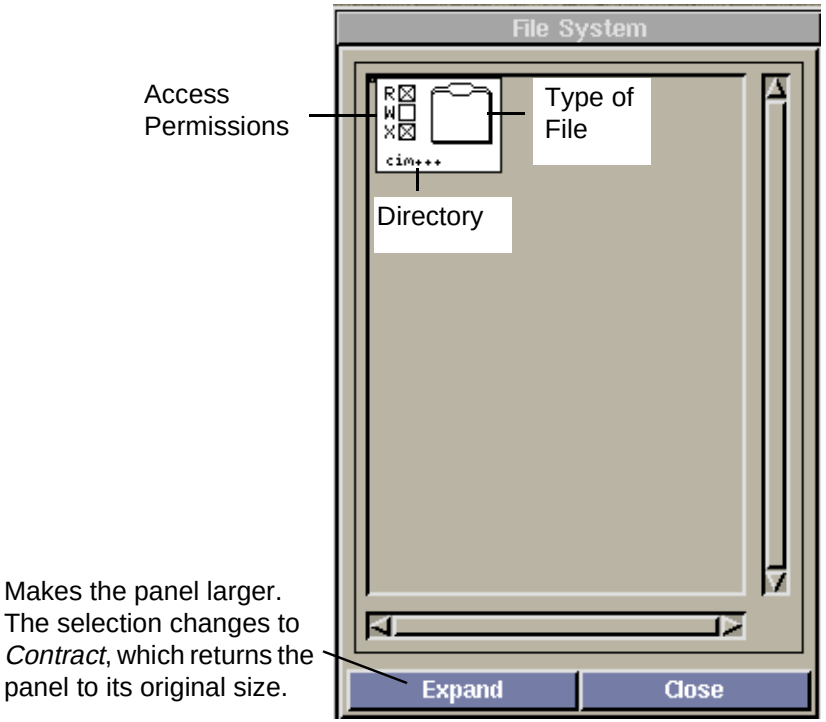


Figure 7-24 The File System panel

Chapter 8

Running a Simulation

After the workcell has been completed and you have chosen the utilities you would like to include, such as collision detection, you are ready to run the simulation. There are two ways to simulate a part program: **interactive**, where you execute a single simulation and **batch**, where you group multiple simulations together and execute them sequentially.

Both interactive and batch simulations are set up and run using the **Simulate** pulldown menu.

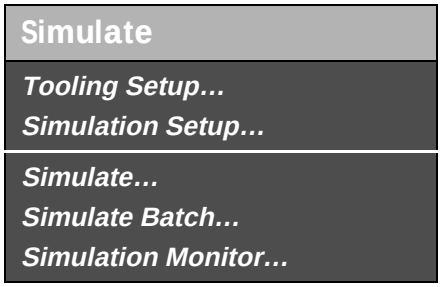


Figure 8-1 The **Simulate** menu

Table 8-1 describes the selections available from the **Simulate** menu.

Selection	Description
Tooling Setup…	Displays the Tool Setup panel. See Chapter 6, "Modeling NC Tooling".
Simulation Setup…	Displays the Simulation Setup panel, which is used to set up an interactive simulation. See "Setting Up an Interactive Simulation" on page 8-2.
Simulate…	Displays a machine pendant for the current machine. The machine pendant controls and executes an interactive simulation. See "Using the Machine Pendant" on page 8-12.

Table 8-1 **Simulate** selections

Selection	Description
Simulate Batch…	Displays the Batch Mode Simulate panel, which is used to set up and execute batch simulations. See “Batch Mode Set Up and Simulation” on page 8-5.
Simulation Monitor…	Displays the Simulation Monitor panel. See “The Simulation Monitor” on page 8-19.

Table 8-1 **Simulate** selections (continued)

Setting Up an Interactive Simulation

Selecting *Simulation Setup…* from the **Simulate** pulldown menu displays the Simulation Setup panel.

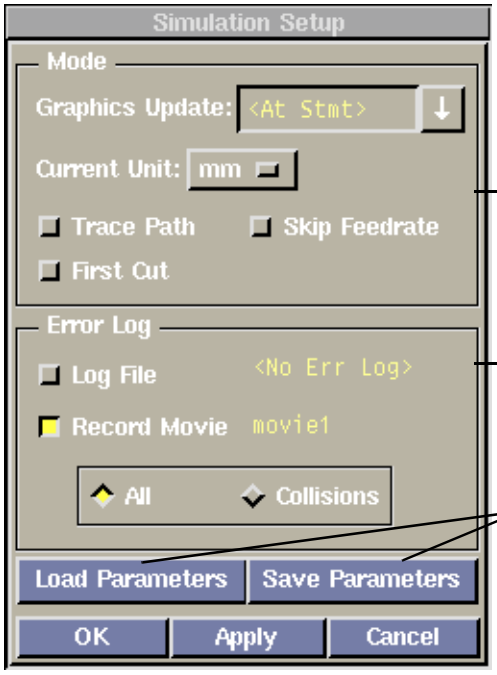


Figure 8-2 The Simulation Setup panel

Interactive Simulation Parameters

Table 8-2 describes the selections available from the Mode box.

Selection	Description
Graphics Update	Sets the rate that the *Graphics Window* will be updated. Setting to <At Stmt> refreshes the graphics after every G-code statement.
Current Unit	Sets the workcell units.
❑ Trace Path	Enables tracing of tool center path during simulation. During the simulation, trace lines are generated. They are shown in a different color to distinguish cutter changes. Once generated, these trace lines are workcell objects. By default, trace lines are adopted under the workcell object labeled "part." If there is no workcell object labeled "part" when ❑ Trace Path is switched on, a pop up box prompts you to select an object. The selected object will then be the parent for the trace lines.
❑ Skip Feedrate	Programmed feedrates are ignored during simulation. When this is switched on, the simulation will proceed in rapid feedrate mode.
❑ First Cut	Displays the First Cut Setup panel. See Appendix B, "First Cut".

Table 8-2 Mode selections

Recording Errors

Table 8-3 describes the selections available from the Error Log box.

Selection	Description
❑ Log File	Switching this on prompts you to enter a filename for the log and creates an error log file containing error messages generated during the simulation.

Table 8-3 Error Log selections

Selection	Description
❑ Record Movie	Switching this on prompts you to enter a filename for a movie. You then have the option to record the entire simulation, or just the collisions.
	◆ All — This option records the entire simulation process.
	◆ Collisions — Records collisions (applicable when collision detection is active).
	NOTE For information on using collision detection, see page 7-3).

Table 8-3 Error Log selections (continued)

When running a simulation with ❑ Record Movie switched on, program blocks are recorded in the movie as they are being executed. The program blocks are also displayed in the *Graphics Window* as they occur.

Loading and Saving Simulation Parameters

Selecting *Load Parameters...* from the Simulation Setup panel displays the Select Parameter File panel.

Figure 8-3 The Select Parameter File panel

The parameter configurations can be saved by clicking *Save Parameters* from the Simulation Setup panel. A name requestor prompts you to specify a name for the current parameter configuration.

Batch Mode Set Up and Simulation

Batch mode simulation enables you to execute a series of jobs (simulations) in an "unattended" mode. After completing a batch mode simulation, you can review error logs and movies for each job.

A batch file is composed of a number of jobs. Each job references a previously-saved workcell and a set of specified simulation parameters.

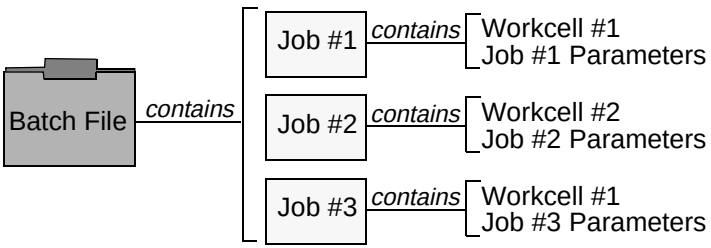


Figure 8-4 Batch file structure

The same workcell can be referenced by any number of jobs.

These steps outline the procedure for creating a batch file:

1. Create and save appropriate workcells for each job.

   Each workcell should contain all the necessary items for the simulation: the machine, part, fixturing, and tool library. Collision detection pairs need to have been set up. Other parameters are specified in the Set Job Parameters panel.

2. Create an empty batch file.

   Creating a batch file is done by selecting *Load/Create Batch* in the Batch Mode Simulate panel. A name requestor prompts you to specify a name for the batch file.

3. Add jobs to the batch file.

   Jobs are added by selecting *Add Job…*. A name requestor prompts you to specify a name. After specifying a name, the Set Job Parameters panel will be displayed.

4. Edit and save simulation parameters for each job.

   Job parameters are specified and saved using the Set Job Parameters panel.

5. Save the batch file.

   The batch file is saved by selecting *Save Batch Setup*.

Using the Batch Mode Simulate Panel

Selecting *Simulate Batch...* from the **Simulate** pulldown menu displays the Batch Mode Simulate panel.

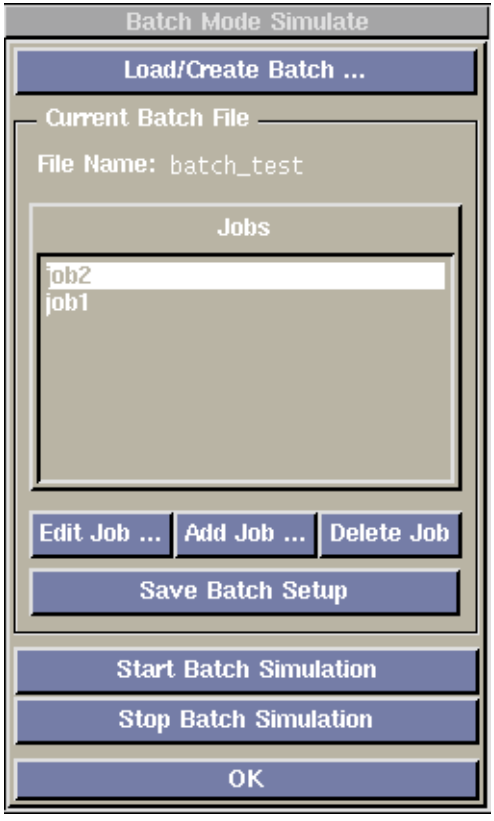


Figure 8-5 The Batch Mode Simulate panel

Tool Bar Shortcut Clicking this tool bar button displays the Batch Mode Simulate panel.

Table 8-4 describes the selections in the Batch Mode Simulate panel.

Selection	Description
Load/Create Batch…	If there are previously-saved batch files in the current directory, this selection displays the Select Batch File list containing the available batch files in the current project library and the <new> selection. You can retrieve an existing batch file or create a new one. When you want to create a new batch file, you are prompted to enter a name. If there are no previously-saved batch files in the current directory, a name requestor prompts you to specify a name for a new batch file. You can change project libraries by using the Install or Save panel.
File Name	Displays the current batch file.
Jobs	Displays the jobs associated with the current batch file.
Edit Job…	Displays the Set Job Parameters panel, which enables you to edit the highlighted job. See Figure 8-6, “The Set Job Parameters panel” on page 8-11.
Add Job…	Displays the Select Job File list containing the available jobs and the <new> selection. You can add an existing job to the batch file, or create a new one. When you want to create a new job, you are prompted to enter the name of the new batch file.
Delete Job	Deletes the highlighted job from the batch file.

Table 8-4 Batch Mode Simulate selections

Selection	Description
Save Batch Setup	Saves the current batch setup. Clicking this selection displays a name requestor. The **.bat_list** extension will be added to the specified name. The batch file will be saved in the current project library under the **part_prog** subdirectory.
Start Batch Simulation	Starts simulating each job in the current batch file.
Stop Batch Simulation	Stops the simulation.

Table 8-4 Batch Mode Simulate selections (continued)

Using the Set Job Parameters Panel

The Set Job Parameters panel is displayed when a new job is created by using the *Add Job...* selection in the Batch Mode Simulate panel. You can also display the panel for an existing job by selecting *Edit Job...* from the Batch Mode Simulate panel, which is shown on page 8-11.

Table 8-5 describes the selections available from the Set Job Parameters panel.

Selection	Description
Job Name	Displays the current job being edited. You can select a different job from the Jobs list in the Batch Mode Simulate panel.
Project	Displays the current project area.
Cell	Selects a workcell to be associated with the current job.The list button lists all workcells in the current project library.
Machine	Displays the name of the machine to be simulated. This field is automatically updated with the name of the machine in the selected workcell.

Table 8-5 Set Job Parameters selections

Selection	Description
Part Prog	Selects the part program to simulate.
Start At	Selects where the simulation will start. The number selections in the list refer to actual block numbers, such as N10, N20. Block numbers that are not included in the list can be manually entered into the field. Selecting <tof> starts the simulation at the "top of file" (the first line of the file).
End At	Selects where the simulation will end. Selecting <eof> ends the simulation at the "end of file" (the last line of the file).
Err Log	Error log filename. The default is the job name.
Movie	Specifies a movie name. To record a movie, ❑ Record Movie must be switched on.
❑ Trace Path	Same as the ❑ Trace Path selection in the Simulation Setup panel. See page 8-3.
❑ First Cut	Switching this on enables material removal simulation for the current job and displays the First Cut Setup panel. **NOTE** For more information on material removal, see Appendix B, "First Cut".
❑ Save Cell After Job	Switching this on overwrites the current workcell with the workcell as it is after the job is completed. Items created during the simulation, such as trace paths, will also be saved.
❑ Record Movie	Switching this on will record a movie using the filename specified in the Movie field. You have the option to record the entire simulation, or just the collisions. ◆ All — The option records the entire simulation process.

Table 8-5 Set Job Parameters selections (continued)

Selection	Description	
	◆ Collisions	Records collisions (applicable when collision detection is active). **NOTE** For information on using collision detection, see page 7-3).
Save	Saves job parameters in the current project library in the **`part_prog`** subdirectory. The **`.job`** extension is added to the job name.	

Table 8-5 Set Job Parameters selections (continued)

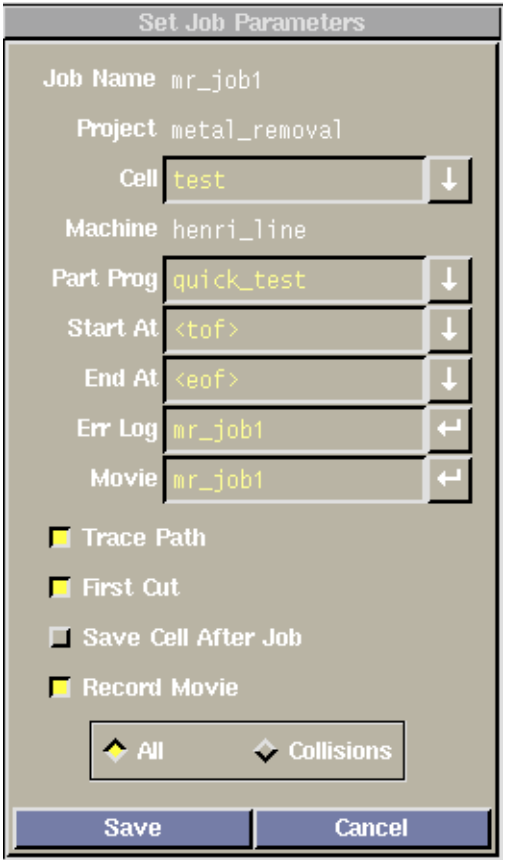
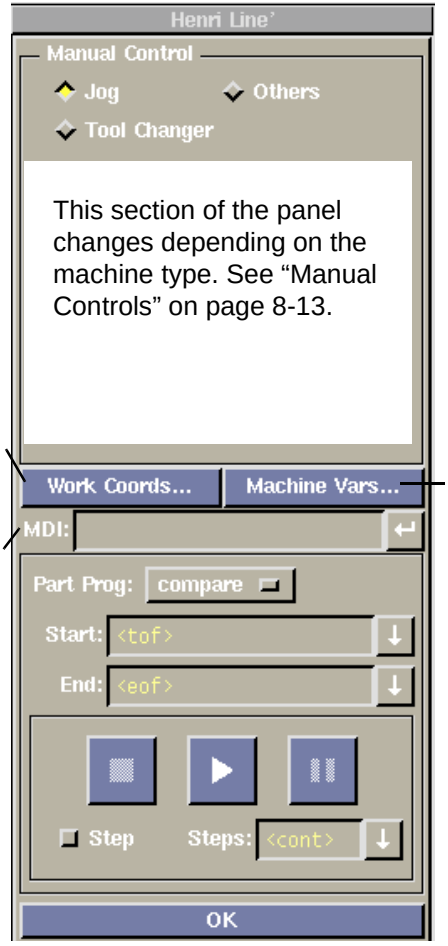


Figure 8-6 The Set Job Parameters panel

Using the Machine Pendant

The machine pendant enables you to manually setup a machine tool before running the part program. Selecting *Simulate...* from the **Simulate** pulldown menu displays a machine pendant for the installed machine.



Described in "Changing the Workpiece Coordinates" on page 8-15.

Manual Data Input, which enables you to enter G and M codes.

Described in "Changing the Machine Variables" on page 8-18.

This section is described in "Setting Up Part Program Simulation" on page 8-14.

Figure 8-7 Example of a machine pendant

Tool Bar Shortcut Clicking this tool bar button displays the machine pendant.

In order to display the machine pendant, you must have a machine installed. The panel is displayed for the machine that you last installed. The machine pendant depends on the machine selected—when a different machine is loaded into the workcell, a different machine pendant will be displayed.

If you have more than one machine installed, a pop up box enables you to choose which machine will have its machine pendant displayed.

Manual Controls

The Manual Control box in the machine pendant contains selections to manually control the machine components. The selections are configured to match the controller of the selected machine. This section describes the "standard" controls represented by the Henri Line machine pendant. These controls have been grouped into three sets of selections: ◆ Jog, ◆ Tool Changer, and ◆ Other.

Toggling ◆ Jog displays the Jog Axes selections:

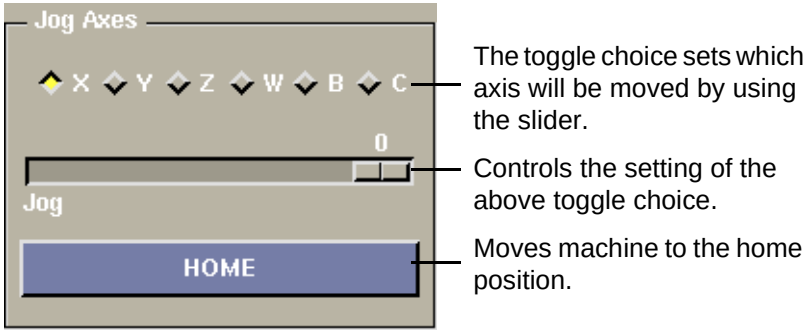

Jog Axes
X Y Z W B C
0
Jog
HOME
The toggle choice sets which axis will be moved by using the slider.
Controls the setting of the above toggle choice.
Moves machine to the home position.

Figure 8-8 Jog Axes selections

Toggling ◆ Tool Changer displays the selections for moving the tool changer (only available if applicable for the current machine).

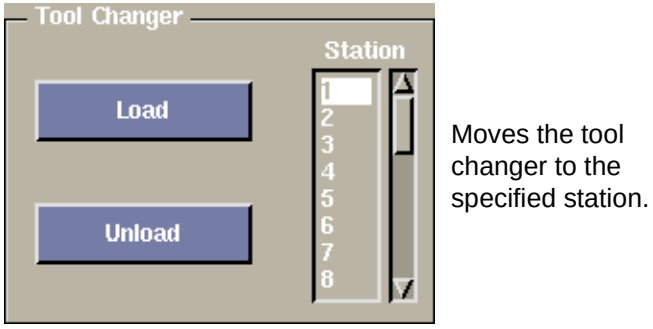


Figure 8-9 ◆ Tool Changer selections

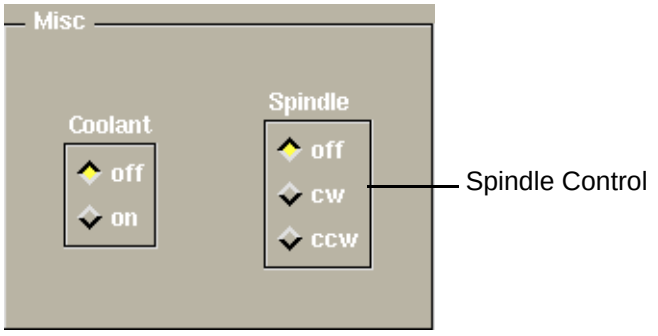


Figure 8-10 ◆ Other selections

Setting Up Part Program Simulation

The Part Prog choice button in the machine pendant lists the available part programs.

The Start list button lists the options of where the simulation will start. Select <tof> if you want the simulation to start at the beginning of the file. You can also use the field to enter a program block number. The simulation will begin at the specified block number.

The End list button lists the options of where the simulation will end. Select <eof> if you want the simulation to stop at the end of the program file. You can also use the field to enter a program block number. The program will end at the specified block number.

The simulation selections are used to simulate the selected part program. Table 8-6 describes the simulation selections available from the machine pendant.

Selection	Description
	Stops a running simulation.
	Simulates the part program. If ❑ Step is switched on, the program will wait each time the specified number of statements has been simulated.
	Pauses the simulation.
❑ Step	Switching this on enables you to simulate the program step-by-step. The simulation will pause when it has simulated the number of statements specified by the Steps setting. You can then either click the Play button to continue the simulation.
Steps	When the part program is going to be simulated step-by-step, this setting determines how often the simulation will pause. Setting Steps to 5, for example, pauses the simulation every fifth step. Setting Steps to <cont> simulates the entire program.

Table 8-6 Machine pendant's simulation selections

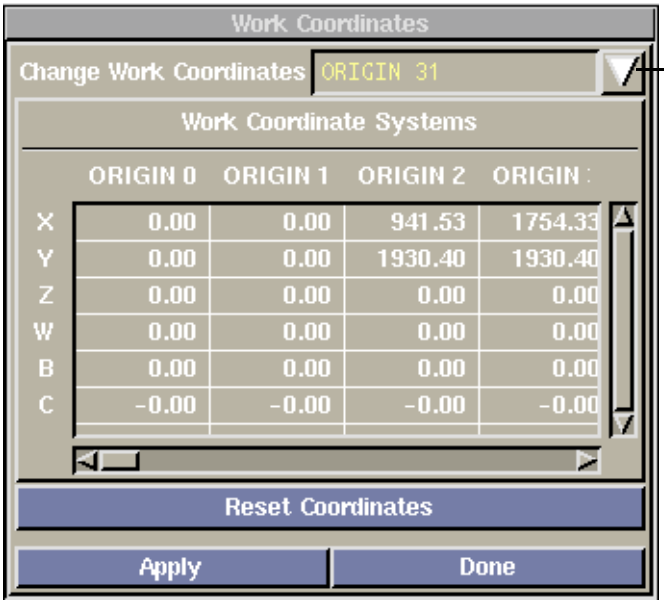
Changing the Workpiece Coordinates

The Work Coordinates panel displays the current workpiece coordinates table of the soft machine. Each column in the table represents one workpiece coordinate system (Work Piece Coordinates are sometimes called fixture offsets or machine coordinate systems (MCS)). Each row in the table displays the coordinates of each axis in each workpiece coordinate system.

The number of workpiece coordinates are determined by the CNC controller. Common CNC controllers use the following convention:

FANUC	G53	Represents machine coordinates and cannot be edited
	G54 - G59	Represents workpiece coordinates 1 to 6
Cincinnati Milacron	H0	Represents machine coordinates and cannot be edited
	H1 - H16	Represents Fixtures Offsets 1 to 16
	D1 - D16	Represents Programmable Offsets 1 to 16
Fadal	E0	Represents machine coordinates and cannot be edited
	E1 - E6	Represents workpiece coordinates 1 to 6

Clicking *Work Coords...* from a machine pendant displays the Work Coordinates panel. The Work Coordinates panel is configured to match the controller of the selected machine. Figure 8-11 shows the Work Coordinates panel for the Henri Line.



Selects a work coordinate to be changed. The Move Object panel is displayed once a selection is made.

Figure 8-11 The Work Coordinates panel

To change a preset work coordinate:

1. Select the workpiece coordinate that you want to change using the Change Work Coordinates list button. The Move Object panel is displayed.

2. Use the Move Object panel to move the specified machine coordinate frame to the new location.

> **NOTE** The Move Object panel is described in “Moving Objects” on page 5-5.

3. In the Work Coordinates panel, click *Apply*.

Reset Coordinates resets the coordinate frames to a default location.

Changing the Machine Variables

The Machine Variables panel is used to add, change or delete machine variables. Clicking *Machine Vars...* from a machine pendant displays the Machine Variables panel. The Machine Variables panel is configured to match the controller of the selected machine. Figure 8-12 shows the Machine Variables panel for the Henri Line.

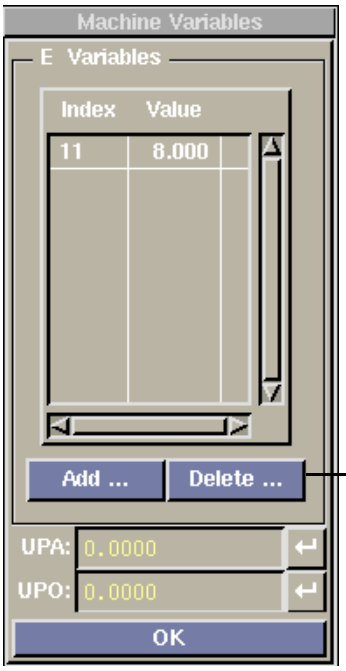


Figure 8-12 The Machine Variables panel

To add an E variable:

1. Click *Add...*. A pop up box is displayed. This pop up box is used to enter an integer that will be used as the E variable index number.

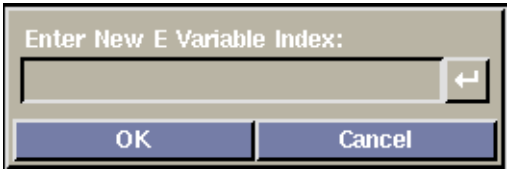


Figure 8-13 E variable index pop up box

2. Enter an integer. A pop up box is displayed. This pop up box is used to enter the value that will be assigned to the E variable.

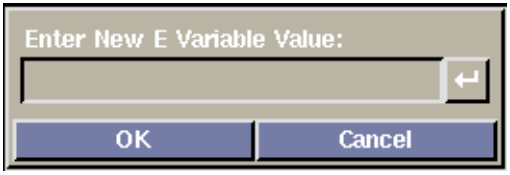
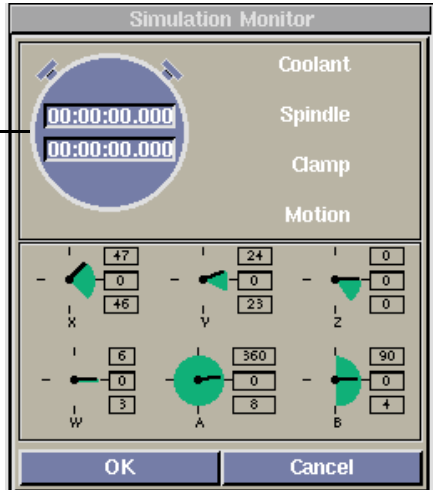


Figure 8-14 E variable value pop up box

3. Enter a value. The index is added to the table in the Machine Variables panel.

The Simulation Monitor

Selecting *Simulation Monitor...* from the **Simulate** pulldown menu displays the Simulation Monitor panel.



Simulation Clock (described below).

Displays current machine status.

Displays axis positions.

Figure 8-15 The Simulation Monitor panel

Tool Bar Shortcut Clicking this tool bar button displays the Simulation Monitor panel.

The Simulation Clock displays information about the simulation and is used to pause the simulation.

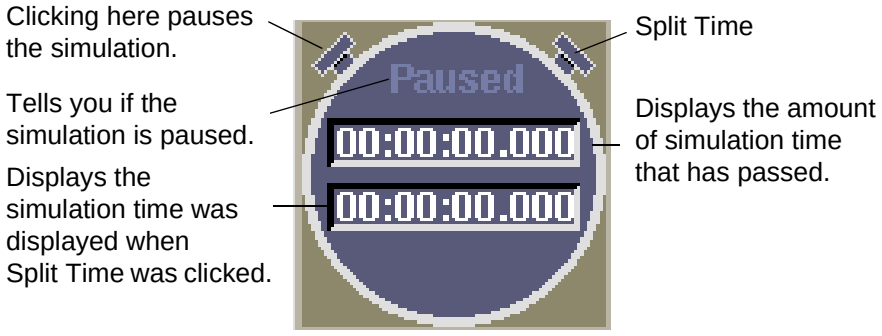

Clicking here pauses the simulation.
Tells you if the simulation is paused.
Displays the simulation time was displayed when Split Time was clicked.
Split Time
Displays the amount of simulation time that has passed.
Paused
00:00:00.000
00:00:00.000

Figure 8-16 The Simulation Clock

Split Time is used to compare the amount of time that has passed since a certain point in the simulation.

Appendix A

IGES Conversions

Soft Machines supports an IGES (Initial Graphics Exchange Specification) to Soft Machines and Soft Machines to IGES interface. Soft Machines converts IGES files to Soft Machines models and Soft Machines models to IGES files. Using this interface, you can access and use models built on external CAD modeling systems and put into IGES format. Models built using Soft Machines can be converted to IGES format and used by other CAD/CAM systems as well. In this way, IGES provides a link between Soft Machines and other CAD/CAM systems.

The IGES Standard

The IGES standard was developed to provide a common data format for describing the engineering characteristics of physical objects. These characteristics include shape, size, and structure, along with various accompanying data used to annotate or enhance these characteristics.

Using the IGES standard, three-dimensional models, engineering drawings, and other graphics-related product data can be shared among disparate CAD/CAM databases. The IGES standard describes only a common data format—it is not a communications protocol.

In the IGES format, product data is divided into geometric and non-geometric categories. **Geometric data** describes the shape and size (form) of the physical object. Examples of geometric data are points, lines, arcs, cubic splines, planes, and parametric surfaces. **Non-geometric data** is used for annotation (as in engineering drawings), for identifying groupings of data, and for assigning various attributes or properties to the data.

All geometric and non-geometric data is expressed in terms of **entities**, which is the fundamental IGES information unit. All entities are categorized by type and assigned a corresponding type number in order to differentiate one type of entity from another. For example, the geometric circular arc entity has an entity type number of 100 while the

non-geometric text font definition entity has the entity type number 310. Many entity types have variants called forms which are identified by their associated form numbers.

All data on a product, including the entities used to describe that product, comprise an IGES file. Each individual IGES file is composed of a number of 80-column records, or **cards**, organized into five sections: **start**, **global**, **directory entry**, **parameter data**, and a **terminator**.

start The start section is used as a general heading for the file. The start section may contain a description of the file contents, a title for the file, or any other descriptive information. The records in the start section are composed of ASCII character strings, and are used mainly for identification.

global The global section contains information necessary to convert data from the IGES format to the native formats used by Soft Machines and other CAD/CAM systems. For example, the global section may contain the number of bits for integer and floating point numerical representation, scale factor and units, file name, vendor IDs, and date and time the file was created.

directory The directory entry section serves as an index for all geometric and non-geometric entity data in the file. This section contains one two-record entry for each entity. Each entry lists certain attributes for the entity it introduces along with pointers to other directory entries or parameter section entries which contain specific information for the entity.

parameter The parameter data section contains the actual parameter data associated with each entity introduced in the directory section. Parameter entries are free-formatted and may consist of any number of records, but they must contain pointers to their associated directory entries.

terminator The terminator consists of a single record which lists the number of records in each section of the file. It may be used to check for extraneous data or data omissions.

Two different IGES formats, ASCII and binary, are available. Soft Machines, however, uses ASCII format only. The Soft Machines IGES conversion software is based on IGES Version 4.0 which is detailed in the National Bureau of Standards publication number NBSIR 88-3813 (AF) *Initial Graphics Exchange Specification (IGES), Version 4.0*.

Restrictions on IGES Conversions

The following entities are used when converting IGES models to Soft Machines models:

Entity	Description
Basic geometric entities:	
100	circular arc
102	composite curve
104	conic arc (parabola, ellipse, hyperbola)
106	copious data (chains of points)
108	plane
110	line
112	parametric spline curve
114	parametric spline surface
116	point

Table A-1 IGES entities used in conversion

Entity	Description
118	ruled surface
120	surface of revolution
122	tabulated cylinder
124	transformation matrix (frame)
126	rational B-spline curve
128	rational B-spline surface
Structural entities:	
212	general note
308	subfigure definition
402	associativity
408	singular subfigure instance
410	view
412	rectangular array subfigure
414	circular array subfigure
Geometric and annotation entities (import only):	
202	angular dimension
206	diameter dimension
208	flag note
210	general label
212	general note
214	leader (arrow)
216	linear dimension

Table A-1 IGES entities used in conversion (continued)

Entity	Description
218	ordinate dimension
220	point dimension
222	radius dimension
228	general symbol
404	drawing entity
	NOTE Entity 212 is used only for handling text pointers on parameter cards.
Solid geometric entities (import only):	
	NOTE Solids are imported as sets of bounding surfaces.
140	offset surface
150	block
152	right angular wedge
154	right circular cylinder
156	right circular cone frustrum
158	sphere
160	torus
162	solid of revolution
164	solid of linear extrusion
168	ellipsoid
	NOTE Solid entities 150-168 are represented as sets of parametric surfaces.
Trimmed surface geometric entities (import only):	
142	curve on a parametric surface

Table A-1 IGES entities used in conversion (continued)

Entity	Description
144	trimmed surface

Table A-1 IGES entities used in conversion (continued)

Table A-2 describes IGES annotation types supported in Soft Machines.

Type Number	IGES Type Description
202	Angular Dimension Entity
206	Diameter Dimension Entity
208	Flag Note Entity
210	General Label Entity
212	General Note Entity
214	Leader (Arrow) Entity
216	Linear Dimension Entity
218	Ordinate Dimension Entity
220	Point Dimension Entity
222	Radius Dimension Entity
228	General Symbol Entity (including geometric tolerance)
404	Drawing Entity

Table A-2 Supported IGES annotation types

If you build your model on another CAD system, but intend to use it primarily with Soft Machines, limit the data for these models to this subset of entities in order to prevent loss of information.

Importing Large Models

If you import large model files or CAD parts, you may need to increase the values of two variables. For new products, these variables are located in the file: **`cim/templates/base/lisp.ini`**

For existing products, these variables are located in the file: **`cim/templates/<template name>/lisp.ini`**

If you see the error message **too many objects in putobj—need to increase alloca_stack_size**, follow these steps:

1. At the end of the appropriate file, add the command:

   alloca_stack_size = 24000000;

2. Add **malloc_max** to the file (it can be added anywhere) by adding the command:

   malloc_max = 30000000;

By increasing the **alloca_stack_size** from 6000000 to 24000000, you increase the swap space requirement by 18 MB.

NOTE Refer to the *Installation Guide* for information on swap space requirements for your hardware platform.

IGES Conversions Using the Panels

The IGES to Soft Machines conversion routine ignores most of the values in the **`globals`** section of the IGES file. The values it uses are

- Delimiter character
- End of record delimiter
- Unit flag and units

This section discusses menus and panels that are used to import an IGES file to Soft Machines, and to import a Soft Machines file to IGES.

The CAD Interface Panel

The CAD Interface panel is displayed by selecting *Import/Export Model...* from the **Modeling** pulldown menu.

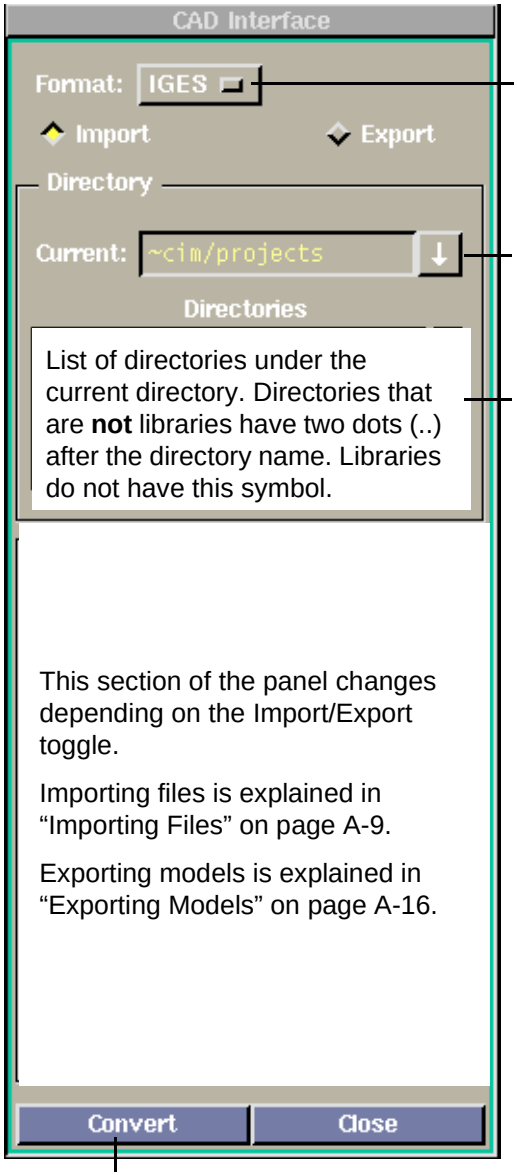

CAD Interface
Format: IGES
Import
Export
Directory
Current: ~cim/projects
Directories
List of directories under the current directory. Directories that are **not** libraries have two dots (..) after the directory name. Libraries do not have this symbol.
This section of the panel changes depending on the Import/Export toggle.
Importing files is explained in "Importing Files" on page A-9.
Exporting models is explained in "Exporting Models" on page A-16.
Convert
Close
Should display *IGES* for IGES conversions.
Sets the directory. You can use the list button to select **~cim/projects** or **~cim/users**, or use the field to enter any directory on the system. See "Libraries" on page 1-23.
Selecting a directory from this list makes it the current directory.
Performs the conversion.

Figure A-1 The CAD Interface panel

Importing Files

Toggling ◆ Import provides selections for reading in and converting your IGES files.

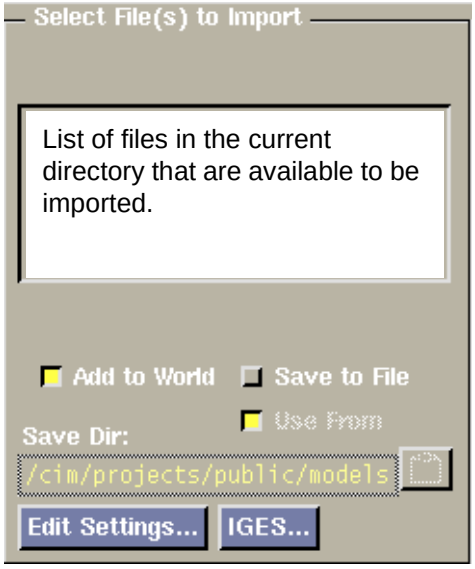


Figure A-2 ◆ Import selections

❑ Add to World

Switching this on installs the converted model into the current workcell.

❑ Save to File

If this is switched off, the converted model will be not be saved. Switching this on specifies that you would like to save the converted model. Either the ❑ Use From or Save Dir selections are used to specify the directory where the converted model will be saved.

❑ Use From

Switching this on saves the imported file in the current directory. Switching this off enables you to specify a different directory using the Save Dir selections. This selection is only available if you have specified that you want to save the file by switching on ❑ Save to File.

Save Dir

These selections are used to specify a directory where the converted model will be saved. These selections are only available if you have specified that you want to save the file by switching on ❑ Save to File and that you do not want to save the file in the current directory by switching off ❑ Use From.

Clicking this button displays a list used to select a directory. You can also enter a directory name in the field.

Edit Settings…

Displays the Edit Settings panel, which is described in the following section.

IGES…

Displays the Iges Settings panel, which is described on page A-15.

Editing the Imported Model's Settings

The Edit Settings panel provides three main categories of attributes that the model will possess after it has been imported: ◆ Skip, ◆ Resolution and ◆ Compaction. Clicking *Edit Settings...* displays the Edit Settings panel.

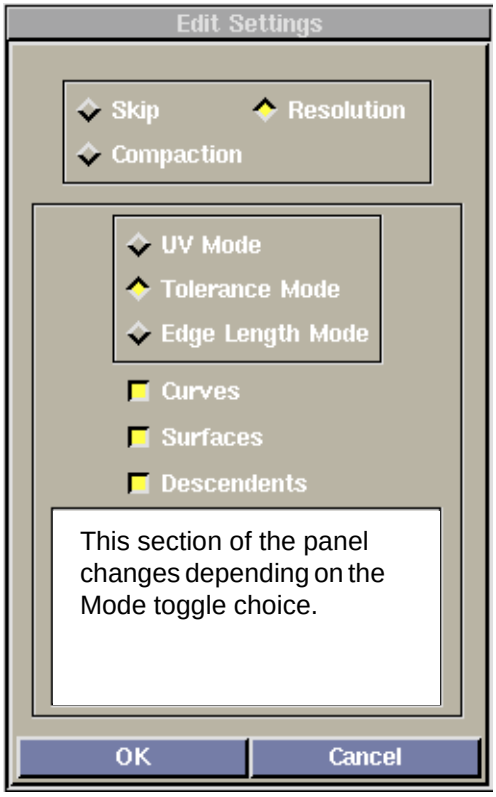


Figure A-3 The Edit Settings panel (with ◆ Resolution toggled)

Editing Resolution

Toggling ◆ Resolution enables you to modify segment length or facet size on parametric models.

Low resolutions (fewer facets) will speed up the graphics for large CAD models, however the models will look "rough". High resolution will make the models look more real, but may slow the

graphics of some platforms. Setting the proper resolution is important as it can achieve a good balance between performance and appearance.

Table A-3 describes the three modes.

Selection	Description
◆ UV Mode	Specifies the facetization as a two-dimensional grid. This is not recommended since it does not optimize the number of facets. You need to specify three fields: Surface U, Surface V and Boundary. Boundary is the resolution of the trimmed surface boundary.
◆ Tolerance Mode	Specifies the maximum allowable deviation of the faceted representation from the actual analytic surface. This optimizes the number of facets by creating more where the curvature is high, and fewer where surfaces are flat.
◆ Edge Length Mode	Specifies the size of the facets, but does not optimize.

Table A-3 Modes

Table A-4 describes the available switches that determine the kind of geometry that will be edited.

Selection	Description
❑ Curves	Edits resolution on curves according to the current mode.
❑ Surfaces	Edits resolution on surfaces according to the current mode.

Table A-4 Geometry switches

Selection	Description
❑ Descendents	Edits resolution on all the descendents of the selected shape.

Table A-4 Geometry switches (continued)

Skipping Attributes

Toggling ◆ Skip displays 4 switches, which serve as filters:

❑ Remove Curves

Skips both discrete and analytic curves during conversion.

❑ Remove Surfaces

Skips both discrete and analytic surfaces during conversion.

❑ Remove Analytic

Removes the analytic description of the entities after their conversion.

❑ Remove Non-geometry

Skips entities with no geometry during conversion.

Editing Compaction

Toggling ◆ Compaction provides selections for changing the tree structure of a specific model by creating a bond between objects.

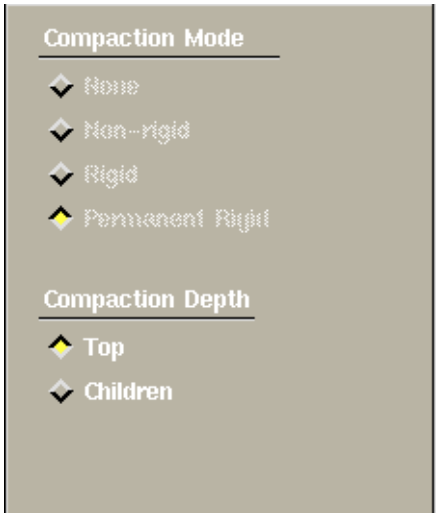


Figure A-4 ◆ Compaction selections

◆ Rigid

Structures the tree of the selected object such that the child objects are considered to be affixed to the parent object, and are no longer considered separate entities. If the parent object moves, its children will move also. In addition, the children are not permitted to move relative to one another. You must move the parent to move the children.

Using rigid compaction increases performance on certain platforms.

◆ Non-rigid

Structures the tree of the selected object such that the child objects are considered to be affixed to the parent object, but the child objects can still move relative to one another.

◆ Permanent Rigid

Structures the object tree such that the all objects, whether parent or child, are considered to be on one level. This option provides maximum graphics performance and minimum memory consumption, but cannot be reversed.

Changing the IGES Settings

The Iges Settings panel is used to specify attributes to be included or ignored when importing the IGES file. Clicking *IGES...* displays the Iges Settings panel.

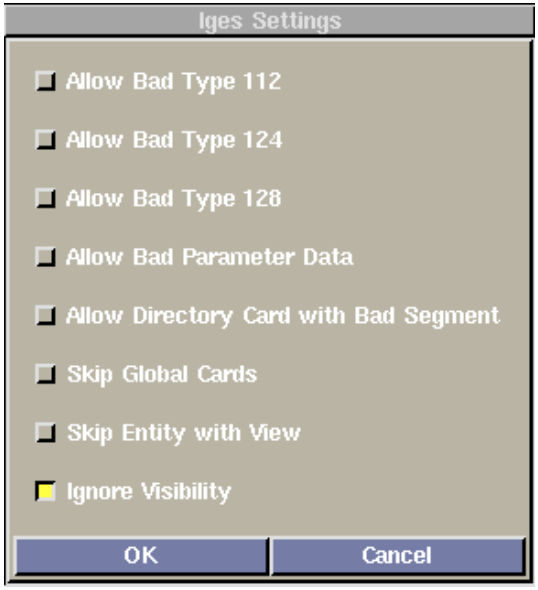


Figure A-5 The Iges Settings panel

Exporting Models

Toggling ◆ Export provides selections for converting Soft Machines models to IGES files. Once converted, you can edit them with other CAD/CAM systems.

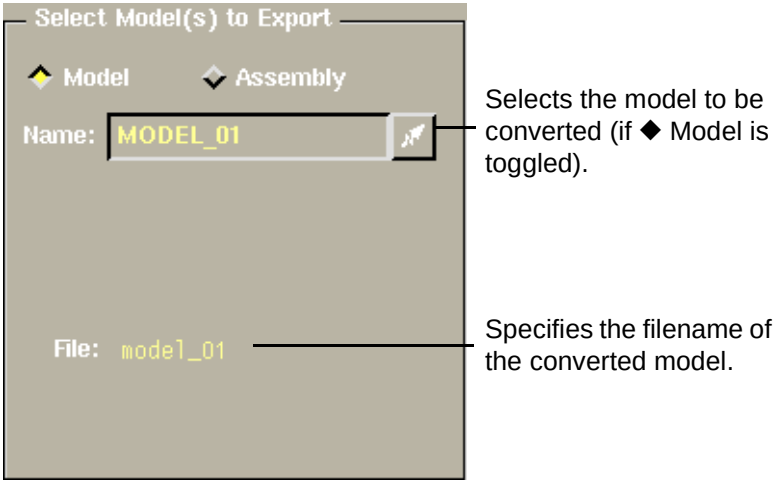


Figure A-6 ◆ Export selections

Appendix B

First Cut

First Cut integrates the material removal functionality and the machining analysis features of Cimplex NCV with Soft Machines. Using Soft Machines with First Cut enables you to graphically view and verify both the material removal process and the complete machine tool motions before releasing the program to the shop floor. First Cut enables you to input post-processed NC program files.

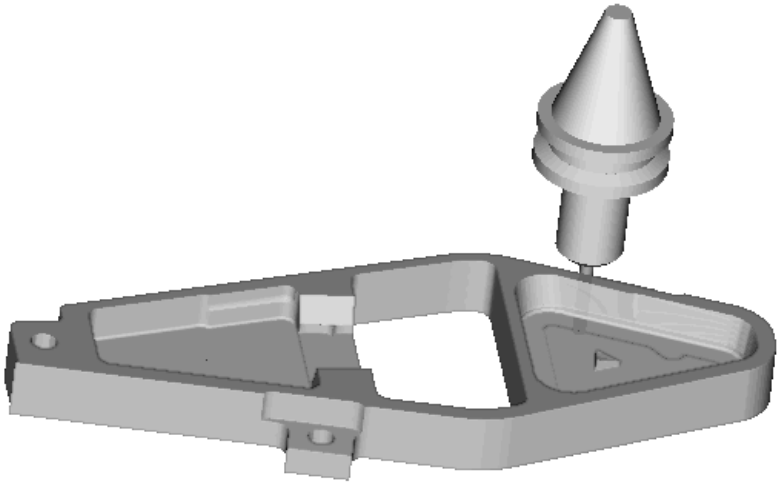


Figure B-1 First Cut

First Cut significantly reduces the need for the physical verification process and its related costs.

First Cut Features

The following are the main features of First Cut:

- ➢ Simulation of complex multi-axis cutter motion. Material removal is displayed in full color shaded images.
- ➢ Several types of errors are detected automatically: rapid cuts, cuts into fixtures, tool-holder collisions, and cutting above the flute length. During the simulation, the

color of the cutter changes to red to indicate rapid motions. When a rapid motion cuts the part, the cut is displayed in red and an error message is reported.

- Errors are displayed in the *Machine Part Program Window* and recorded in an error log file.
- Material removed by each cutter can be automatically displayed in a different color.
- The cursor can be used to point to any location on the model to determine the precise coordinates, the surface normal vector, and the material thickness.
- SLA files in ASCII format can be read, and the geometry from the file can be created as part, fixture or stock.
- An as-designed part from an SLA file can be graphically compared to the machined part; the as-designed part is displayed translucently and overcuts and undercuts are highlighted.
- The current volume and volume removed can be displayed during or after the simulation.
- The images of the machined part can be rotated a specific number of degrees about the horizontal or vertical axis. Also, the image can be rotated dynamically about the horizontal or vertical axis.
- Models can be sectioned through any specified plane either by using the mouse to digitize the point at which the part is to be sectioned, or by entering the coordinates and the plane normal for the point.
- Machining of deep features can be observed by making the stock translucent or by sectioning the stock during simulation.
- The light source can be moved dynamically, and shadows can be rendered, to see details of the surface finish and for better realism.

➢ The material removal process can be recorded into a playback file. A faster play back speed is provided.

How First Cut Works

First Cut is an interactive graphics system that you can use to reduce the time and cost involved in generating error-free NC programs. The NCV simulation is designed to help identify and correct inefficient tool motions.

First Cut provides a visual image for the verification of numerical control machining operations. The simulation of tool motion and material removal provides a graphical representation of a work-in-process model. As the cutter follows the tool paths specified by the NC programmer, the user sees the part emerging from the stock. This process improves shop floor productivity by providing a cost effective alternative to “tape tryouts” on the machine tool.

Processing can be interrupted, at any time, and the view modified to

- ➢ Inspect an apparent error
- ➢ Measure any particular point on stock or part thickness
- ➢ Rotate the part vertically or horizontally, or zoom in on the view, for inspection of particular areas
- ➢ Section cut the model

First Cut has many features, such as pointing, image enhancement, flip, and zoom, that are used to evaluate the work-in-process model.

The simulation session can be run interactively, or one or more input files can run unattended (see “Batch Mode Set Up and Simulation” on page 8-5 for more information). In either mode, you can record the session for later play back. You can detect errors and identify inefficient tool motions either “live” during the simulation, or when replaying the playback file.

Setting Up First Cut

The First Cut Setup panel is used to set parameters for the First Cut machining view. Switching on ❑ First Cut in the Simulation Setup panel displays the First Cut Setup panel.

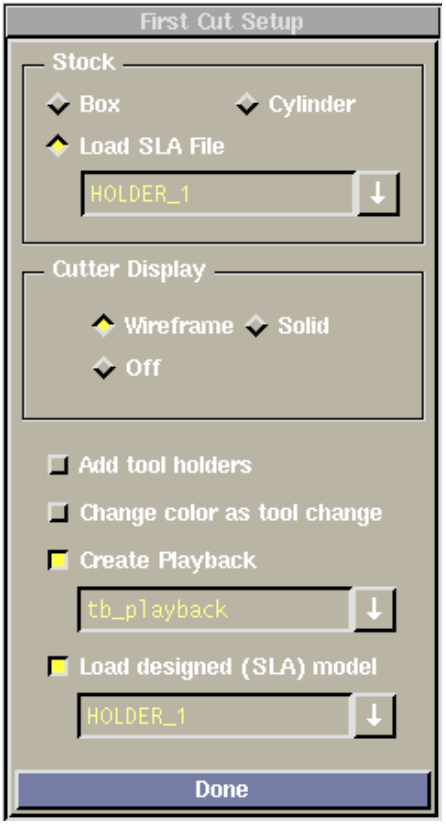


Figure B-2 The First Cut Setup panel

NOTE The Simulation Setup panel is described in “Setting Up an Interactive Simulation” on page 8-2.

The selections in the First Cut Setup panel are described in the following sections.

Selecting the Settings

Defining the Stock

There are three options for defining the stock: ◆ Box, ◆ Cylinder and ◆ Load SLA File.

◆ Box

Generates a box stock model for the simulation. First Cut calculates a bounding box that will enclose the workcell object named “part” and its children.

NOTE For information on installing a part into the workcell, see “Installing Workcell Objects” on page 5-2.

◆ Cylinder

Generates a cylindrical stock model for the simulation. First Cut calculates the cylinder’s dimensions using a similar process as ◆ Box.

◆ Load SLA File

Displays an unrestricted list button which is used to select an SLA file in the current directory.

NOTE Before loading an SLA file, make sure the current units match the units used to create the SLA file. If you would like to change the units, see “Changing the Workcell Defaults” on page 5-4.

To create an SLA file to be used in First Cut, see the *CAD Interfaces* manual available from SILMA, Division of Adept Technology, Inc.

Setting the Cutter Display Options

◆ Wireframe

The cutter is displayed in wireframe. This is the default setting.

◆ Solid

The cutter is displayed as a solid object.

◆ Off

The cutter display is turned off during simulation.

❑ Add tool holders

Switching this on adds tool holders to the First Cut simulation and detects cuts beyond the flutes of the cutter.

❑ Change color as tool change

Switching this on changes the color of the cuts each time a cutter change is encountered in the NC program.

Creating a Playback File

❑ Create Playback is used to record a movie of the machining process as it is shown in the *First Cut Display Window*. Switching on ❑ Create Playback displays an unrestricted list button which is used to specify the filename that will be given to the playback file. Playback files are given the **`.play`** extension and are saved in the **`simulation`** subdirectory of the current directory.

Loading an SLA Model of the "As-Designed" Part

❑ Load designed (SLA) model is used to load an SLA model that is designated as the "as-designed" part. This "as-designed" part is compared to the "as-machined" part produced by First Cut. Switching on ❑ Load designed (SLA) model displays an unrestricted list button which is used to select the filename of the SLA model. When creating an SLA model, the pose of the exported SLA model must match the pose of the "part" model.

NOTE

Before loading an SLA model, make sure the current units match the units used to create the SLA model. If you would like to change the units, see "Changing the Workcell Defaults" on page 5-4.

To create an SLA model to be used in First Cut, see the *CAD Interfaces* manual available from SILMA, Division of Adept Technology, Inc.

Accepting the Settings

To accept the First Cut settings:

1. Click *Done* in the First Cut Setup panel.
2. Click *OK* in the Simulation Setup panel.

Using First Cut

Setting Up the First Cut Default View

When the Play button is selected in the machine pendant, the current Soft Machines view of the part becomes the default First Cut view. For this reason, it is important to choose an optimal view that will give the best vantage point of the entire machining process before selecting the Play button.

NOTE

Chapter 8, "Running a Simulation" provides instructions for running the simulation.

Starting a simulation from the machine pendant displays the *First Cut Display Window*.

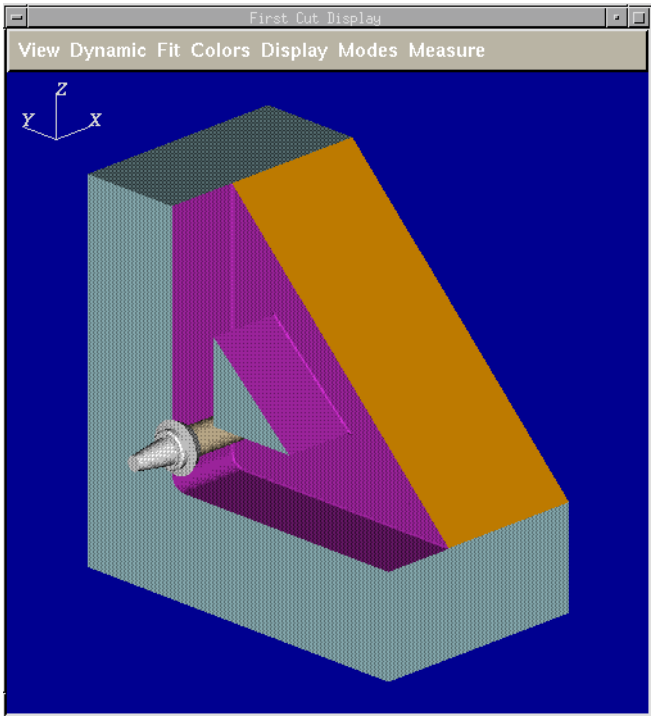
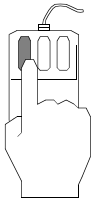
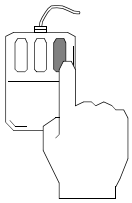


Figure B-3 The *First Cut Display Window*

Using the Mouse

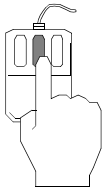


In First Cut, the left mouse button is used to select menu items and making selections in the *First Cut Display Window*. The middle and right mouse buttons are used for manipulating the model and changing views.



The right mouse button is used to perform a "Zoom Window" function in the *First Cut Display Window*. To use Zoom Window, hold down the right mouse button and drag the cursor to form a rectangle around the area you would like to zoom in on. Releasing the mouse button expands the selected area to fill up the entire screen.

In Simulation Mode, you should stop or pause the simulation before using Zoom Window. When you resume or re-start the simulation, the view reverts to the original, "unzoomed" view. If you use Zoom Window while the part is being cut, the view will be redrawn gradually. You can reset the view using *Reset* in the **Modes** menu (see "Modes Menu" on page B-14).



When the simulation is paused or stopped, the middle mouse button can be used to dynamically rotate or zoom the view, depending on which option is selected in the **Dynamic** menu (see "Dynamic Menu" on page B-11).

First Cut Display Window Selections

Table C-1 describes the *First Cut Display Window* selections and tells you where the menu is described in greater detail.

Menu	Description
View	Enables you to set the view orientation in the window. See "View Menu" on page B-10.
Dynamic	Enables you to dynamically rotate, zoom or change the light source. See "Dynamic Menu" on page B-11.

Table C-1 *First Cut Display Window* selections

Menu	Description
Fit	The **Fit** selections are unavailable in this version of First Cut.
Colors	Enables you to set the color of cuts. See “Colors Menu” on page B-13.
Display	Enables you to switch on and off the display of the axes and shadows. See “Display Menu” on page B-14.
Modes	Enables you to section the model, rotate it, and compare the as-manufactured model with the as-designed part. See “Modes Menu” on page B-14.
Measure	Enables you to take various measurements on the part model. Chip removal is also carried out here. See “Measure Menu” on page B-19.

Table C-1 *First Cut Display Window* selections (continued)

View Menu

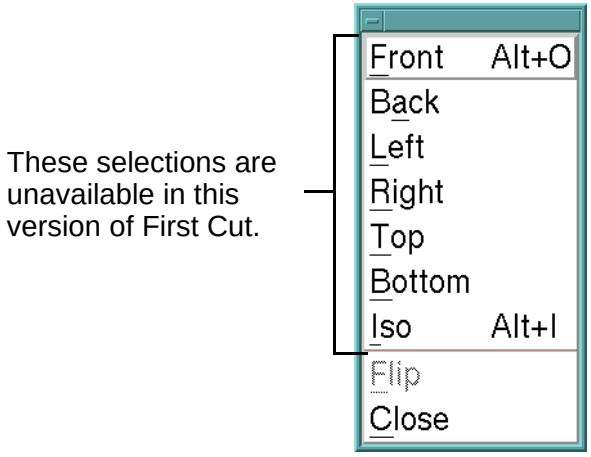


Figure B-4 The **View** menu

Flip enables you to rotate the part through 180 degrees around your current vertical axis. For example, if you have a front view, the image will be flipped over to a back view. Selecting *Flip* again returns the part to the original view.

If you select *Close*, you will be asked to confirm that you wish to close the *First Cut Display Window*.

Dynamic Menu

The **Dynamic** menu contains the dynamic viewing modes.

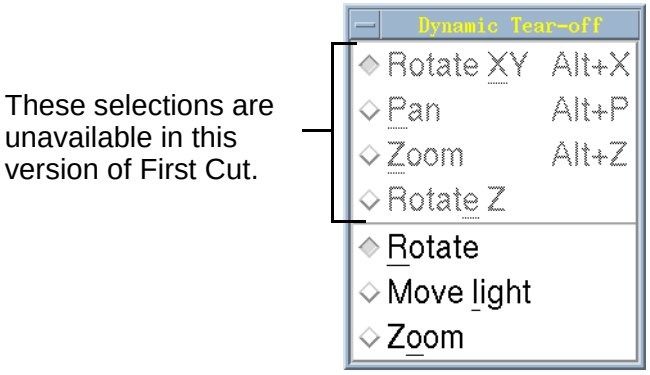


Figure B-5 The **Dynamic** menu

The **Dynamic** menu selections are described in the following sections.

◆ Rotate

You can dynamically rotate the part model by following these steps:

1. Toggle ◆ Rotate from the **Dynamic** menu.
2. Place your cursor to the left or right of center in your view of the part.
3. Hold down the middle mouse button.

4. Drag the mouse left or right to rotate about the vertical axis. To rotate about the horizontal axis, do the same thing above or below the center of your view of the part and drag the cursor up or down.

◆ Move light

You can dynamically move the light source in a window:

Toggle ◆ Move light in the **Dynamic** menu, then either click the middle mouse button or drag it to place the light source. Clicking (or letting up) the button in the center of the window places the light source at the eyepoint, where it is normally. Clicking or letting up at the edges of the viewport places the light source in that direction, at right angles to the line of sight. Clicking or letting up in intermediate locations places the light source at intermediate directions.

◆ Zoom

You can dynamically zoom up the image by toggling ◆ Zoom, as an alternative to using Zoom Window,.

As explained in “Using the Mouse” on page B-8, Zoom Window enables you to magnify an area of the *First Cut Display Window* by selecting an area of the view using the right mouse button.

Dynamic Zoom works by toggling ◆ Zoom from the **Dynamic** menu, and then selecting the point to be zoomed in your view; you then press the middle mouse button, and drag the mouse upward until you get the desired degree of magnification.

Colors Menu

Figure B-6 The **Colors** menu

The color choices are used to select the color of the cuts during simulation. The active color button is toggled. First Cut automatically cycles through all colors at each cutter change when the automatic option ❑ Change cut color at cutter change is active

NOTE ❑ Change color at cutter change is described on page B-6.

To change the current color, toggle a different color choice.

The *Repaint* button is used to manually repaint the color of all cuts to the current color.

To change all the cuts to a new color:

1. Toggle one of the color buttons.
2. Select *Repaint.*

Display Menu

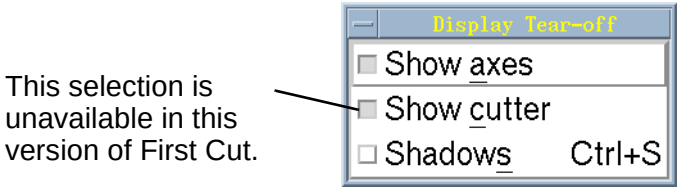


Figure B-7 The **Display** menu

The **Display** menu selections are described in the following sections.

❏ Show axes

When this is switched on, the coordinate axis is displayed at the top left hand corner of the *First Cut Display Window*.

❏ Shadows

Switching this on displays shadows in the window.

Displaying shadows can be useful for highlighting features on the part, and for understanding detail.

NOTE	Shadows are displayed only if the light source has been moved away from the line of sight.

Modes Menu

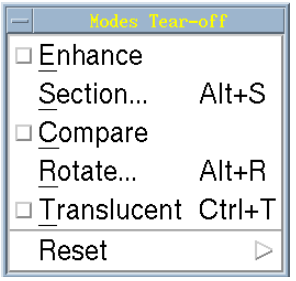


Figure B-8 The **Modes** menu

The **Modes** menu selections are described in the following sections.

❑ Enhance

Switching this on draws a dark line where the edge of one part of the model lies in front of another. This is especially useful where two parts of the model are rendered at the same brightness, making the edge between them invisible. Switching off returns the image to its unenhanced state.

Section…

You can section the part at any time, or run a simulation while the part is sectioned, using the Section panel. Selecting *Section…* from your **Modes** menu displays the Section panel.

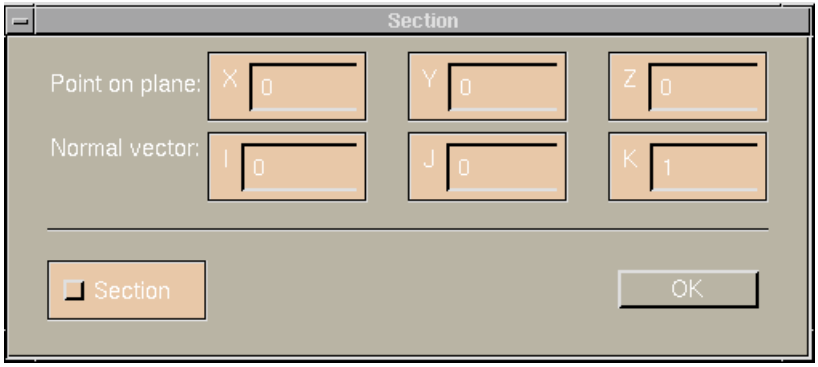


Figure B-9 The Section panel

The section plane is created by clicking at the desired point on the model, as was done in this illustration, and by typing in the plane's normal vector. You can also type in point coordinates.

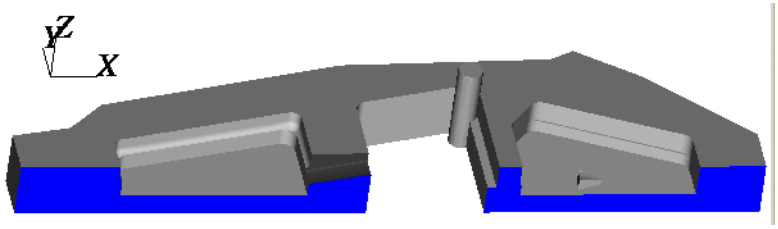


Figure B-10 A section plane

Reset section and *Reset all*, on the **Modes** menu, restores the image of the complete model.

The Normal vector points in the direction of the material to be made invisible. In the case illustrated, everything with a Y coordinate less than 1.81092 will be made invisible.

You can cancel the dialog window, without turning off sectioning, by selecting the *OK* button.

❑ Compare

The Compare function is used to compare the as-designed part with the as-machined part. The "as-designed" SLA model of the part must be selected in the First Cut Setup panel before starting the simulation.

NOTE	The First Cut Setup panel is described on page B-4.

To do the comparison, switch on ❑ Compare from the **Modes** menu in the *First Cut Display Window*.

The part is redrawn in a translucent light-gray color; overcuts (i.e., gouges) are drawn in red; undercuts are drawn in blue. To return to normal display, select the Compare button again.

In comparison mode, the image can be flipped or zoomed, but not rotated.

Rotate…

The Rotate Shaded Image panel is used to swivel the part model about its vertical or horizontal axis, in order to see the part from different angles. Selecting *Rotate...* from the **Modes** pulldown menu displays the Rotate Shaded Image panel.

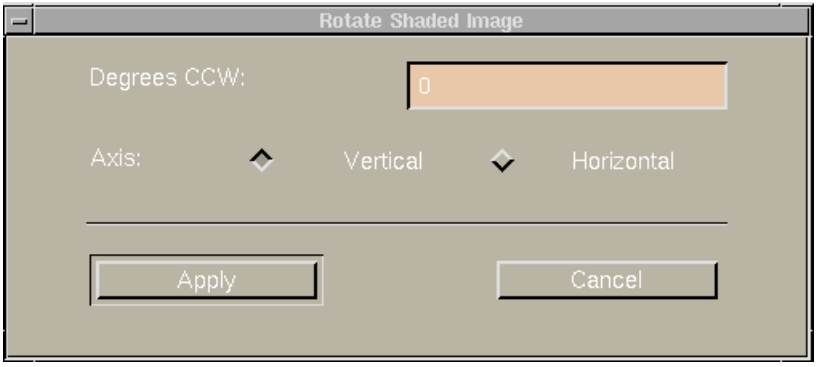


Figure B-11 The Rotate Shaded Image panel

To rotate the part:

1. Enter the number of degrees, negative if you wish, that you want the part to be rotated. The number of degrees is always taken as absolute, and not as an increment or decrement to any previously entered number.

   For vertical rotation, a positive angle causes the front of the part to move to the right, and a negative angle causes it to move to the left. For horizontal rotation, a positive angle rolls the front downwards, and a negative rolls the front upwards.

2. Select *Apply.*

3. Select *Cancel*, or select *Reset all* or *Reset rotation* from the **Modes** menu, to restore the original image.

❏ Translucent

The stock and fixtures can be displayed translucently in simulation mode, including while the simulation is running. This is especially useful for watching the machining of holes and deep pockets, and of features on the back of the part. To toggle this mode on and off, use the ❏ Translucent switch in the **Modes** menu.

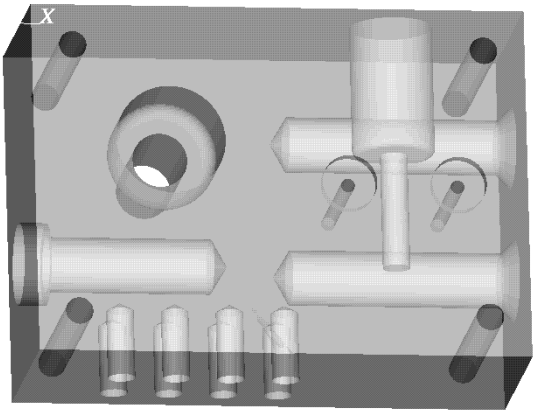


Figure B-12 Switching on ❏ Translucent

Reset

To restore the default viewing options for sectioning, rotation, zooming or lighting, use the *Reset* selections in the **Modes** menu.

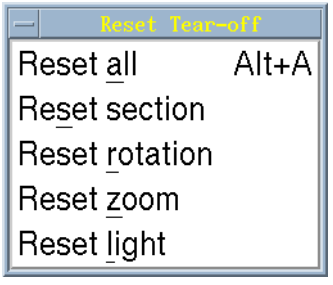


Figure B-13 The *Reset* selections

Table C-2 describes the *Reset* selections.

Selection	Description
Reset all	Resets sectioning, rotation, zoom, and light source.
Reset section	Restores the full view of the part.
Reset rotation	Returns the view to its original orientation.
Reset zoom	returns the view to its original unzoomed state.
Reset light	Returns the light source to its default direction.

Table C-2 *Reset* selections

Measure Menu

The **Measure** menu is used to take measurements on the model, to obtain a reading of machining times, and to remove chips of material for a better view of the cut part. The **Measure** menu is invoked from the *First Cut Display Window*:

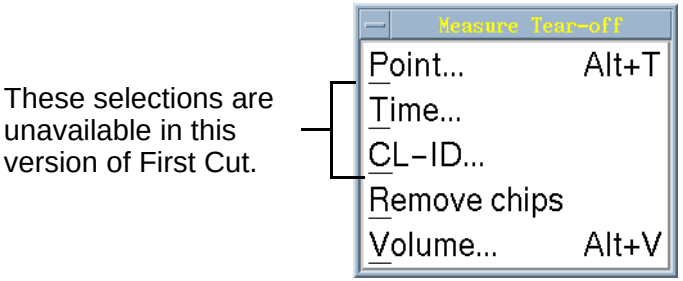


Figure B-14 The **Measure** menu

The **Measure** menu selections are described in the following sections.

Point…

Displays the Measure Point panel. To measure a point on a model, click on the desired point in the *First Cut Display Window* using the left mouse button.

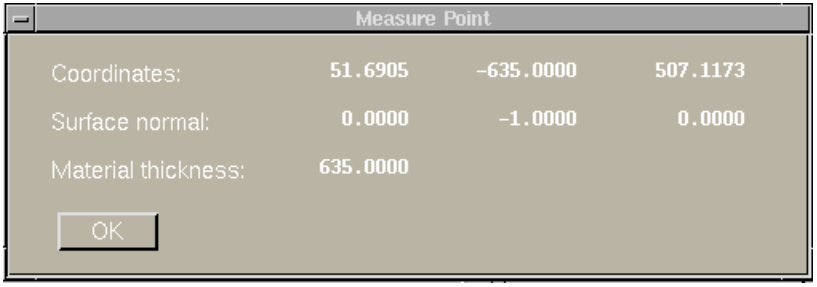


Figure B-15 The Measure Point panel

The Measure Point panel displays the coordinates of the point being measured. The Measure Point panel also displays the surface normal (the direction perpendicular to the surface) and the material thickness.

If you measure cuts such as those above then approximate, rather than precise, coordinates are displayed, and the dialog label changes from "Coordinates:" to "Coordinates (approx):". Also, no surface normal or material thickness are displayed.

If, when determining the material thickness, First Cut finds that the other side of the wall was created by such a cut, the thickness displayed is only approximate, and the label changes from "Material thickness:" to "Material thickness (approx):".

Measurements can be taken when the window is zoomed or sectioned, but not when it is rotated.

Remove chips

To remove material separated from the view of the part:

1. Select the part by clicking on it with the left mouse button.
2. Select *Remove chips* from the *First Cut Display Window*'s **Measure** menu.

While the removal calculation is underway, the part will be shaded in red to show progress.

If you have activated a viewing mode (rotation, enhancement, zooming, sectioning, or comparison) in the *First Cut Display Window*, you will be asked to reset the view and then remove the chips.

Volume…

To measure the volume of the cut part and of the material removed, choose *Volume…* from the **Measure** menu.

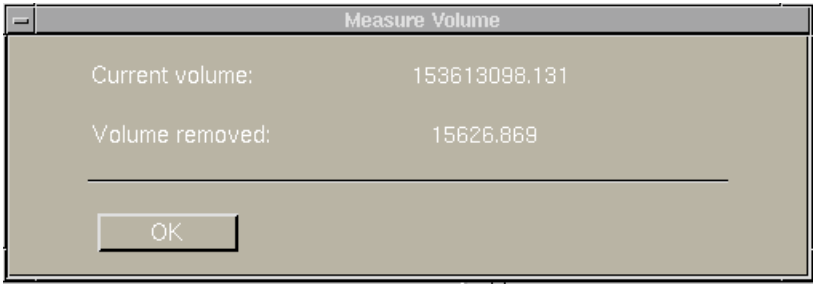


Figure B-16 The Measure Volume panel

The stock must be entirely within the window when the simulation begins. Anything outside the window will be silently ignored by the volume calculations.

If there are chips remaining in the window, they are counted as part of the part volume. To remove them from the calculation, you must remove them from the window; choose *Remove chips* from the **Measure** menu.

With regard to accuracy:

- The numbers are estimates. No uncertainty figures are displayed because there is actually no bound on the possible error. Since First Cut only samples the part surfaces at each pixel, it has no way of knowing how rough the surfaces are, and how much volume is contained, between pixels.

- If no stock faces are seen edge-on (i.e., you have avoided *Front* view, *Side* view, etc.), you can expect an error on the order of one part in W, where W is the width of the part on-screen in pixels. The default window width is 600 pixels, so if your smooth part fills the window, the error would be one part in 600. If several faces are seen edge-on, the error will be roughly three times this, or three parts in W. If you know your part contains small details that are not captured in First Cut's pixel-based solid model, we suggest you avoid calculating the volumes altogether, because there is no way to know how accurate they are. These accuracy considerations are true of all pixel-based verification products.

Using Playback Mode

Playback Mode provides extended capabilities for viewing a recorded simulation. In Playback Mode, you can speed up or slow down the simulation, run it backward or run it to specified checkpoints.

To use Playback Mode, you need to have a playback file loaded.

Loading a Playback File

You can load a newly-created playback file by using the First Cut panel. Selecting Playback loads the playback file that was created in the current simulation.

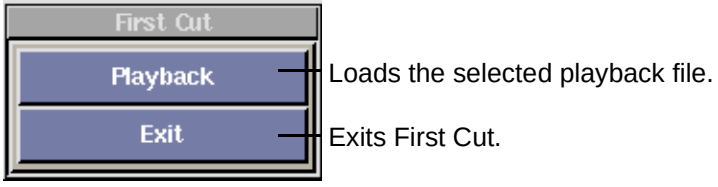


Figure B-17 The First Cut panel

You can load a previously created playback file by using the *First Cut Playback...* selection in the **Utilities** menu.

Selecting *First Cut Playback...* from the **Utilities** menu displays First Cut Playback panel.

Figure B-18 The First Cut Playback panel

Using the *First Cut Playback Control Window*

Once a playback file is loaded, the *First Cut Playback Control Window* provides the ability to use the Playback Mode capabilities.

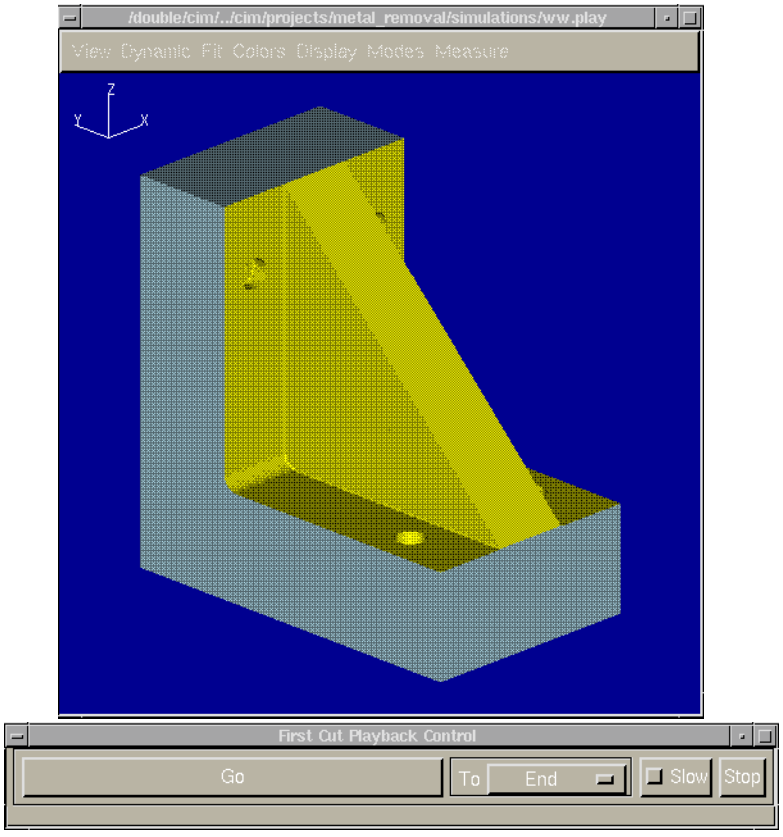


Figure B-19 The *First Cut Playback Control Window*

Table C-3 describes the selections available from the *First Cut Playback Control Window*.

Selection	Description
Go	Starts or resumes playing the currently loaded playback file.

Table C-3 *First Cut Playback Control Window* selections

Selection	Description	
To	Specifies checkpoints where the playback file will pause. Selecting *Go* resumes playback. You can interrupt the selection by selecting *Stop*.	
	Beginning	The playback file will run backwards from the current position to the start of the NC program.
	Prev Error	The playback file will run backwards from the current position to the previous error.
	Prev Cutter	The playback file will run backwards from the current position to the previous cutter change.
	Prev Point	The playback file will run backwards from the current position to the previous NC program block.
	Next Point	The playback file will run until it reaches the next NC program block.
	Next Cutter	The playback file will run until it reaches the next cutter change.
	Next Error	The playback file will run until one of the following conditions are met: • The cutter hits the stock while in Rapid motion. • The cutter hits a fixture. • The holder or cutter shaft hits the stock or fixture. A message describing the error is logged in the error file.
	End	The process will run through the end of the playback file. This is the default setting.

Table C-3 *First Cut Playback Control Window* selections (continued)

Selection	Description
❑ Slow	Switching this on restricts the playback speed to one program block per second. This enables you to see the cutter motions in detail. Switching this off resumes normal playback speed.
Stop	Interrupts playback. The playback can be resumed by selecting *Go*.

Table C-3 *First Cut Playback Control Window* selections (continued)

Appendix C

G & M Codes

This appendix lists the generic G and M codes, along with a brief description.

Code	Function
G00	Point to Point Positioning
G01	Linear Interpolation
G02	Circular Interpolation CW
G03	Circular Interpolation CCW
G04	Program Delay
G05	Unassigned
G06	Parabolic Interpolation
G07	Unassigned
G08	Acceleration
G09	Deceleration
G10 - G12	Unassigned
G13 - G16	Axis Selection
G17	Plane Selection XY
G18	Plane Selection ZX
G19	Plane Selection YZ
G20 - G24	Unassigned
G25 - G27	Permanently Unassigned
G28	Move Axes to HOME Position
G29	Permanently Unassigned

Table B-1 G codes

Code	Function
G30 - G32	Unassigned
G33	Threadcutting, Constant Lead
G34	Threadcutting, Increasing Lead
G35	Threadcutting, Decreasing Lead
G36 - G39	Permanently Unassigned
G40	Radius Compensation OFF
G41	Cutter Compensation LEFT
G42	Cutter Compensation RIGHT
G43	Cutter Offset, Inside Corner
G44	Cutter Offset, Outside Corner
G45 - G49	Unassigned
G50 - G52	Reserved for Adaptive Control
G53	Move wrt Machine Coordinates
G54	Move wrt Work Coordinates 1
G55	Move wrt Work Coordinates 2
G56	Move wrt Work Coordinates 3
G57	Move wrt Work Coordinates 4
G58	Move wrt Work Coordinates 5
G59	Move wrt Work Coordinates 6
G60	Single Direction Positioning

Table B-1 G codes (continued)

Code	Function
G61	Exact Stop Mode
G62	Corner Radius Override
G63	Tapping Mode
G64	Cutting Mode
G65 - G67	Unassigned
G68	Coordinate System Rotation
G69	Coordinate System Rotation
G70	Inch Programming
G71	Metric (mm) Programming
G73	Canned cycle - Rapid Drilling
G74	Canned Cycle - Left Hand Tapping
G75	Unassigned
G76	Canned Cycle - Fine Boring
G77 - G79	Unassigned
G80	Canned Cycle Cancel
G81	Canned Cycle - Spot Drilling
G82	Canned Cycle - Counter Boring
G83	Canned Cycle - Peck Drilling
G84	Canned Cycle - Tapping

Table B-1 G codes (continued)

Code	Function
G85	Canned Cycle - Boring
G86	Canned Cycle - Rapid Boring
G90	Absolute Dimension Input
G91	Incremental Dimension Input
G92	Preload Machine Registers
G93	Inverse Time Feedrate
G94	Inch or mm / min Feedrate
G95	Inch or mm / rev Feedrate
G96	Constant Surface Feedrate
G97	Revolutions per Minute (rpm)
G98	Initial Level Return TRUE
G99	Initial Level Return FALSE

Table B-1 G codes (continued)

The following table lists and describes the M codes.

Code	Function
M00	Program Stop
M01	Optional (Planned) Stop
M02	End of Program
M03	Spindle CW
M04	Spindle CCW
M05	Spindle OFF
M06	Tool Change
M07	Coolant No. 2 ON
M08	Coolant No. 1 ON
M09	Coolant OFF
M10	Clamp
M11	Unclamp
M12	Synchronization Code
M13	Spindle CW and Coolant ON
M14	Spindle CCW and Coolant ON
M15	Motion +
M16	Motion -
M17 - M18	Unassigned
M19	Oriented Spindle Stop

Table B-2 M codes

Code	Function
M20 - M29	Permanently Unassigned
M30	End of Data
M31	Interlock Bypass
M32 - M35	Unassigned
M36 - M39	Permanently Unassigned
M40 - M46	Gear Changes if Used— Otherwise Unassigned
M47	Return to Program Start
M48	Cancel M49
M49	Bypass Override
M50 - M57	Unassigned
M58	Cancel M59
M59	Bypass CSS Updating
M60 - M89	Unassigned
M90 - M99	Reserved for User

Table B-2 M codes (continued)

Appendix D

Product Administration

This appendix explains how to perform product administration tasks to customize Soft Machines. Appendix F, “Soft Machines Software Directories” explains the organization of the Soft Machines software.

The fundamental component of Soft Machines software is the **product**, which is the executable portion of the SILMA software. Products are composed of modules.

The Product Administration panel is used to create and start products and manage user and project areas. To display the Product Administration panel, enter **sspa** in a shell window.

Figure B-1 The Product Administration panel

IMPORTANT	Using this panel will modify the software tree correctly. If you are considering modifying the software using text commands, read Appendix E, "The Software Installation Tree", before doing so.

The **Products** pulldown menu is used to create, edit, deactivate, activate and delete products. See "Working with Products" on page D-2.

The **Projects** and **Users** pulldown menus are used to create, edit and delete project and user areas. See "Working with Project Areas" on page D-6 and "Working with User Areas" on page D-9.

Working with Products

The **Products** pulldown menu is used to create, edit, deactivate, activate and delete products. Products reside in the **`cim/templates`** directory (see "The `templates` Subdirectory" on page F-3).

Figure B-2 The **Products** menu

Creating a New Product

The Create Product panel is used to create new products from modules. Modules include **SILSPEC**s, **SIL I/O**s, products and other options (see "Standard Modules" on page F-5 and "Components of User-Written Modules" on page F-7 for more information).

Selecting *Create...* from the **Products** pulldown menu displays the Create Product panel.

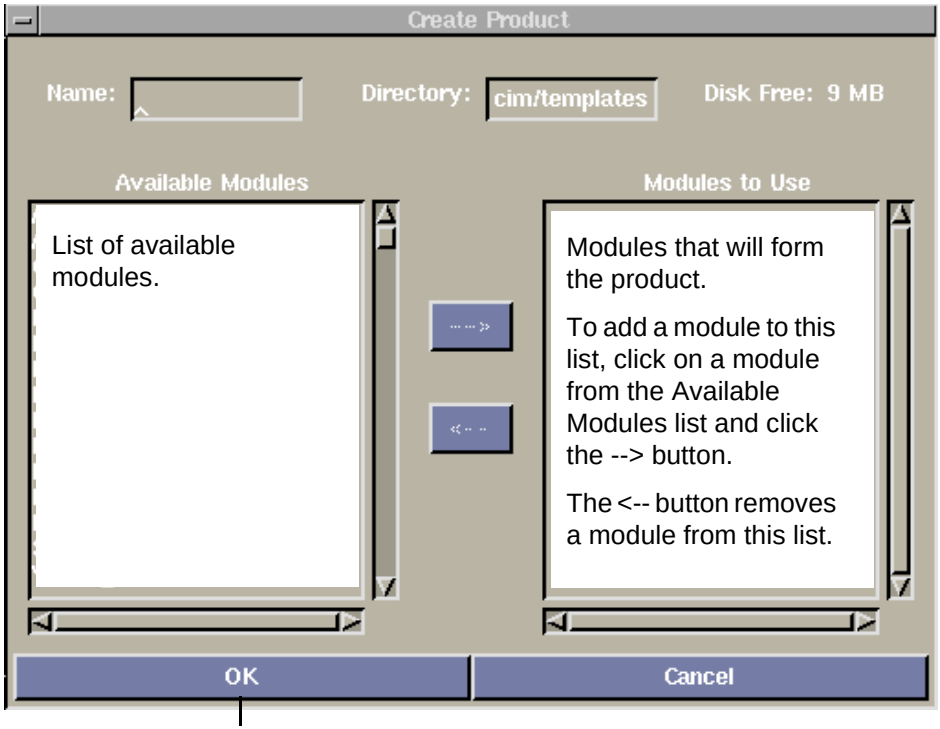

Create Product
Name:
Directory:
cim/templates
Disk Free: 9 MB
Available Modules
List of available modules.
Modules to Use
Modules that will form the product.
To add a module to this list, click on a module from the Available Modules list and click the --> button.
The <-- button removes a module from this list.
OK
Cancel
Clicking *OK* creates a product with the specified name and modules.

Figure B-3 The Create Product panel

The Name field specifies the name of the product.

IMPORTANT	Avoid using upper case characters for product names or filenames. Names are changed to lower case. You cannot create a product if the path contains upper case characters.

The Directory field specifies the directory. By default, products reside in the **`cim/templates`** directory.

Editing a Product

The Edit Product panel is used to change which modules comprise the product. Selecting *Edit...* from the **Products** pulldown menu displays the Select Product to Edit panel.

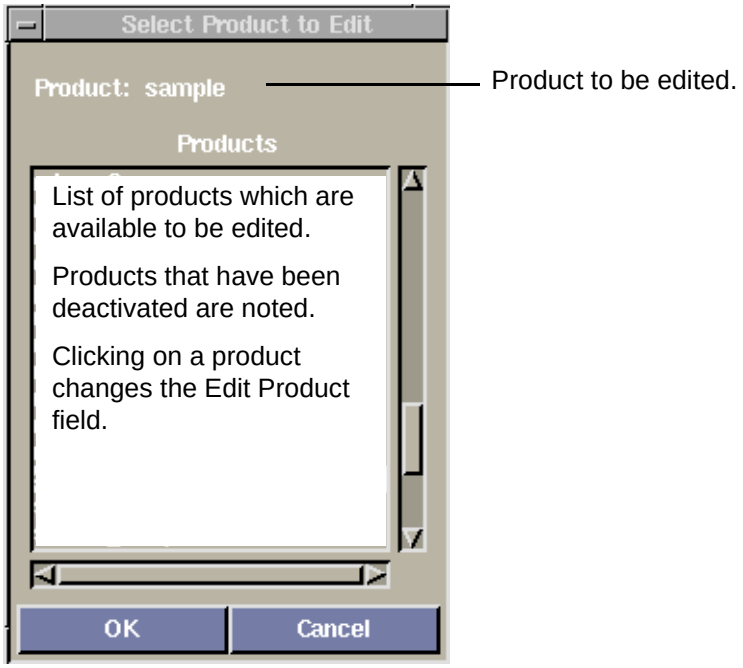

Select Product to Edit
Product: sample
Product to be edited.
Products
List of products which are available to be edited.
Products that have been deactivated are noted.
Clicking on a product changes the Edit Product field.
OK
Cancel

Figure B-4 The Edit Product panel

Clicking *OK* displays the Edit Product panel, which has the same selections as the Create Product panel. You can only edit products that belong to you.

Deleting a Product

The Delete Product panel is used to delete products.

To delete a product:

1. Select *Delete...* from the **Products** pulldown menu. The Delete Product panel is displayed.
2. Select a product in the Products list.

3. Click *OK*. A confirmation request is displayed.
4. Click *OK*. The entire directory where the product resides is deleted. You can only delete products that belong to you.

Activating a Product

The Activate Product panel is used to rebuild products that have been previously deactivated.

To activate a product:

1. Select *Activate...* from the **Products** pulldown menu. The Activate Product panel is displayed.
2. Select a product in the Deactivated Products list.
3. Click *OK*. The product is activated. You can only activate products that belong to you.

Deactivating a Product

Because products occupy between 20 - 25 MB of disk space, you might want to deactivate a product to recover some of the disk space. The deactivated product retains all the information about the included options in the original product (you will not need to select modules again when activating a deactivated product).

To deactivate a product:

1. Select *Deactivate...* from the **Products** pulldown menu. The Deactivate Product panel is displayed.
2. Select a product in the Active Products list.
3. Click *OK*. A confirmation request is displayed.
4. Click *OK*. The product is deactivated. You can only deactivate products that belong to you.

Working with Project Areas

The **Projects** pulldown menu is used to list, create, delete, or rename project areas. Project areas reside in the **cim/projects** directory (see "The projects Subdirectory" on page F-3).

Figure B-5 The **Projects** menu

Creating a New Project Area

The Create Project panel is used to create a new project area. Selecting *Create...* from the **Projects** pulldown menu displays the Create Project panel.

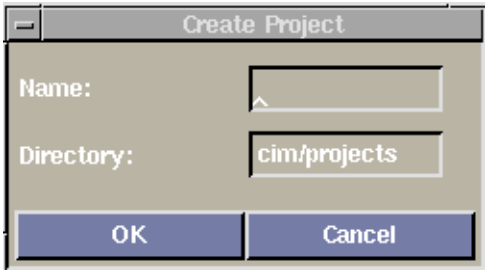


Figure B-6 The Create Project panel

The Name field specifies the name of the project.

IMPORTANT	Avoid using upper case characters for project names or filenames. Names are changed to lower case.

The Directory field specifies the directory. By default, project areas reside in the **cim/projects** directory.

Clicking *OK* creates the specified project area directory. Permissions for the new project area are dictated by the umask of your current login. A link is created from **`cim/projects`** to the new area (see "The `projects` Subdirectory" on page F-3).

Renaming a Project Area

The Rename Project panel is used to rename a project area (using UNIX **mv** command).

To rename a project area:

1. Select *Rename...* from the **Projects** pulldown menu. The Select Project to Rename panel is displayed.

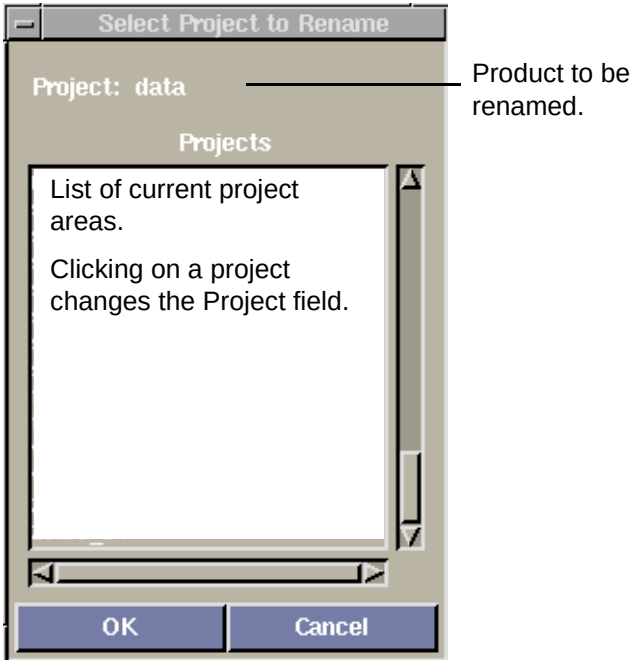


Figure B-7 The Select Project to Rename panel

2. Select a project area from the Projects list.
3. Click *OK*. The Rename Project panel is displayed.
4. Enter the new name in the New Name field.

5. Click *OK*. The project area is renamed.

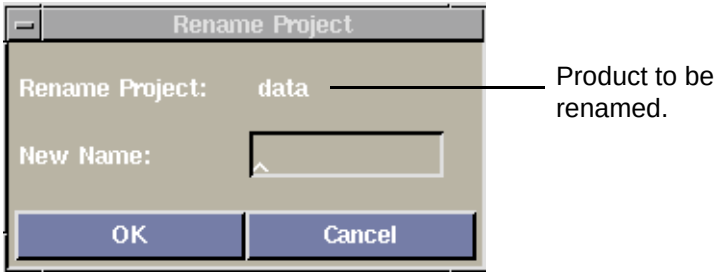


Figure B-8 The Rename Project panel

Deleting a Project Area

The Delete Project panel is used to remove a project area. You can only delete project areas that belong to you.

To delete a project area:

1. Select *Delete...* from the **Projects** pulldown menu. The Delete Project panel is displayed.
2. Select the project area you would like to delete from the Projects list.
3. Click *OK* to confirm your choice.

Working with User Areas

The **Users** pulldown menu is used to list, create, delete, or rename user areas. User areas reside in the **cim/users** directory (see "The users Subdirectory" on page F-4).

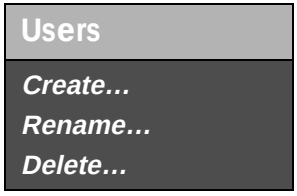


Figure B-9 The **Users** menu

Creating a New User Area

Selecting *Create…* from the **Users** pulldown menu displays the Create User panel, which is used to create a new user area.

NOTE New users are set up using the **cim/scripts/newuser** script, which is explained in the *Installation Guide*.

The Name field specifies the name of the new user area.

The Directory field specifies the directory. By default, user areas reside in the **cim/users** directory.

Clicking *OK* creates the specified the user area directory. Permissions for the new user area are dictated by the umask of your current login. A link is created from **cim/users** to the new area (see "The users Subdirectory" on page F-4).

Renaming a User Area

The Rename User panel is used to rename a user area (using UNIX **`mv`** command).

To rename a user area:

1. Select *Rename...* from the **Users** pulldown menu. The Select User to Rename panel is displayed.
2. Select a user area from the Users list.
3. Click *OK*. The Rename User panel is displayed.
4. Enter the new name in the New Name field.
5. Click *OK*. The user area is renamed.

Deleting a User Area

The Delete User panel is used to remove a user area. You can only delete user areas that belong to you.

To delete a user area:

1. Select *Delete...* from the **Users** pulldown menu. The Delete User panel is displayed.
2. Select the user area you would like to delete from the Users list.
3. Click *OK* to confirm your choice.

Appendix E

The Software Installation Tree

This appendix explains where user data should reside and how modification of the installation tree affects operation.

The structure of the SILMA installation tree is important for both software functionality and the installation of updates. It is designed to separate user data and data shipped from SILMA. This separation allows you to easily update existing software without the danger of removing user data.

The installation tree as it comes off of the installation media should not be modified. New builds areas, libraries, project areas, user areas, and templates should be created using the Product Administration panel (displayed by entering **`sspa`** in a shell window), since it enables you to select a destination directory and creates the necessary symbolic links for you. If you do not use the Product Administration panel to create new areas, you should be aware that while these new areas can reside anywhere on the disk, they must have a symbolic link from the expected location in the installation tree.

There are two main areas that must not be modified:

- The installation tree and its top-level directories (**`builds`**, **`projects`**, etc.) must remain intact and cannot be symbolic links.
- The **`cim/products`** directory must remain intact with no modifications within. Modification of any parts of **`cim/products`**, or the links pointing to them, can result in the failure of future updates.

All unmodified SILMA software resides in the **`cim/products`** directory and the top-level installation tree is made up of links to this directory. Whenever an update is performed, the current areas in **`cim/products`** are removed, along with the links from the top-level installation tree. The new areas are then installed in **`cim/products`** and new links are created.

Because of the volatility of areas located in **`cim/products`**, you should not save data in any of these areas. Project areas shipped from SILMA, with the exception of the **`public`** area, should not be written to. A copy should first be made of the project area so that future updates will not erase user data saved in the area.

Appendix F

Soft Machines Software Directories

This appendix explains the organization of the Soft Machines software.

The basic Soft Machines software is in a directory called **cim**. The **cim** directory consists of eleven subdirectories. For ease in understanding the directories, they have been have been organized into three groups.

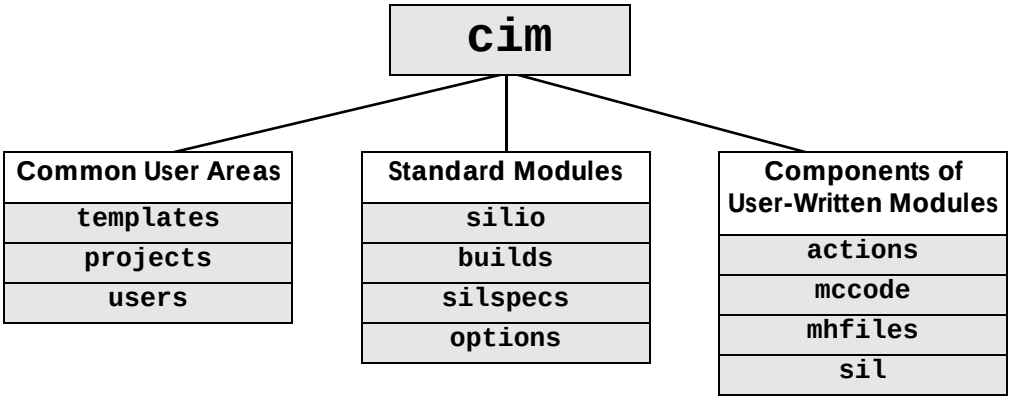
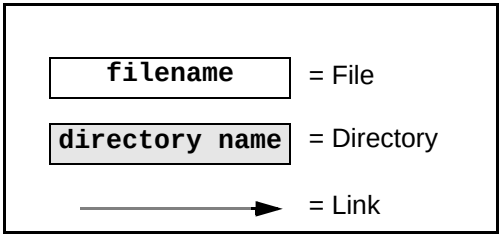


Figure F-1 The Soft Machines directories

A figure illustrating each of the three categories, along with a description of each of the subdirectories, follows. All of the figures in this appendix use the same legend.



Common User Areas

The main subdirectories in this category are **templates**, **projects**, and **users**.

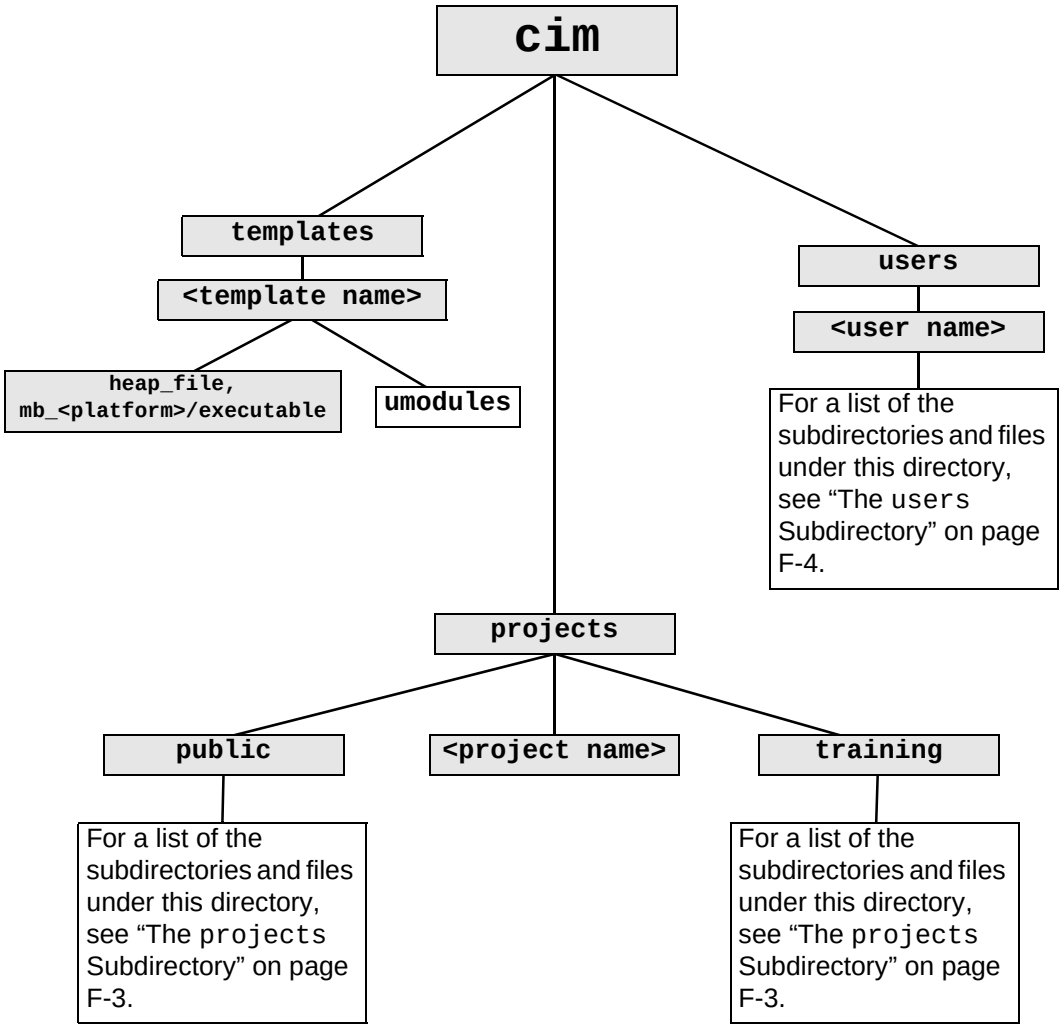


Figure F-2 Common user areas

The `templates` Subdirectory

A **product** is a master copy of the Soft Machines software which contains modules (**SILSPEC**s, **SIL I/O**s, application solutions user code) that you select when you create a product. The **`templates`** subdirectory contains one or more products. See "Working with Products" on page D-2 for details concerning the procedure used to create, edit, deactivate, activate and delete products.

The `projects` Subdirectory

The **`projects`** subdirectory contains separate areas which are referenced by the Soft Machines menu system libraries.

Two standard project areas are included: **`public`** and **`<soft machine name>`** (named after your soft machine). Each project area contains 10 subdirectories.

Subdirectory	File
`cells`	`<cell_name>.ref`
	`<cell_name>.cell`
`models`	`<model_name>.model`
`programs`	`<program_name>.sil`
`simulations`	`<simulation_name>.sim`
`target_code`	`<filename>`
`tools`	`<tool_name>.ee`
`videos`	`<movie_name>.sgm`
	`<movie_name>.cmd`
`nc_tooling`	`<cutting_tool_name>.ct`
	`<tool_holder_name>.th`
	`<tool_changer_name>.tc`
	`<tool_library_name>.tlib`
`part_prog`	`<g_cold_prog_name>.gc`
	`<batch_job_name>.job`
	`<batch_name>.bat_list`
	`<error_log_name>.err_log`
`cad`	`<catia_filename>.exp`

Table C-1 `projects` subdirectories

Subdirectory	File
	<iges_filename>.igs
	<sla_filename>.stl

Table C-1 `projects` subdirectories

The public project area is used to store general files of interest to all Soft Machines users. The **<soft machine name>** area contains information about your Soft Machine.

The project areas are referenced by the Soft Machines menu system libraries when the directory is set to **~cim/projects** in a panel. A detailed description of the libraries is provided in "Libraries" on page 1-23. See"Working with Project Areas" on page D-6 for details concerning the procedure used to setup, rename or delete project areas.

The `users` Subdirectory

The **users** subdirectory contains Soft Machines user areas which are referenced by the menu system libraries. Often, the actual user areas exist outside the **users** subdirectory (i.e., in your login home directory) and may be accessed by Soft Machines through a symbolic link in the Soft Machines **users** subdirectory.

In Soft Machines, an area is set up for each user. This area is the **users** subdirectory described above, with a symbolic link, called **cim**, to the Soft Machines software directory. It consists of 10 subdirectories where Soft Machines stores and retrieves information. These subdirectories are the same as the **projects** subdirectories (see Table C-1).

The user areas are referenced by the Soft Machines menu system libraries when ◆ User is toggled in the Library section of a panel.

Soft Machines user areas are kept in the **users** subdirectory of the **cim** tree. These may be the actual user areas, or may be symbolic links to existing user areas outside of the Soft Machines software directory. It is common for Soft Machines user areas to be kept in each user's login home directory.

User areas are usually set up during Soft Machines software installation. See"Working with User Areas" on page D-9 for details concerning the procedure used to setup, rename or delete user areas.

Standard Modules

The main subdirectories in this category are **silio**, **builds**, **silspecs**, and **options**.

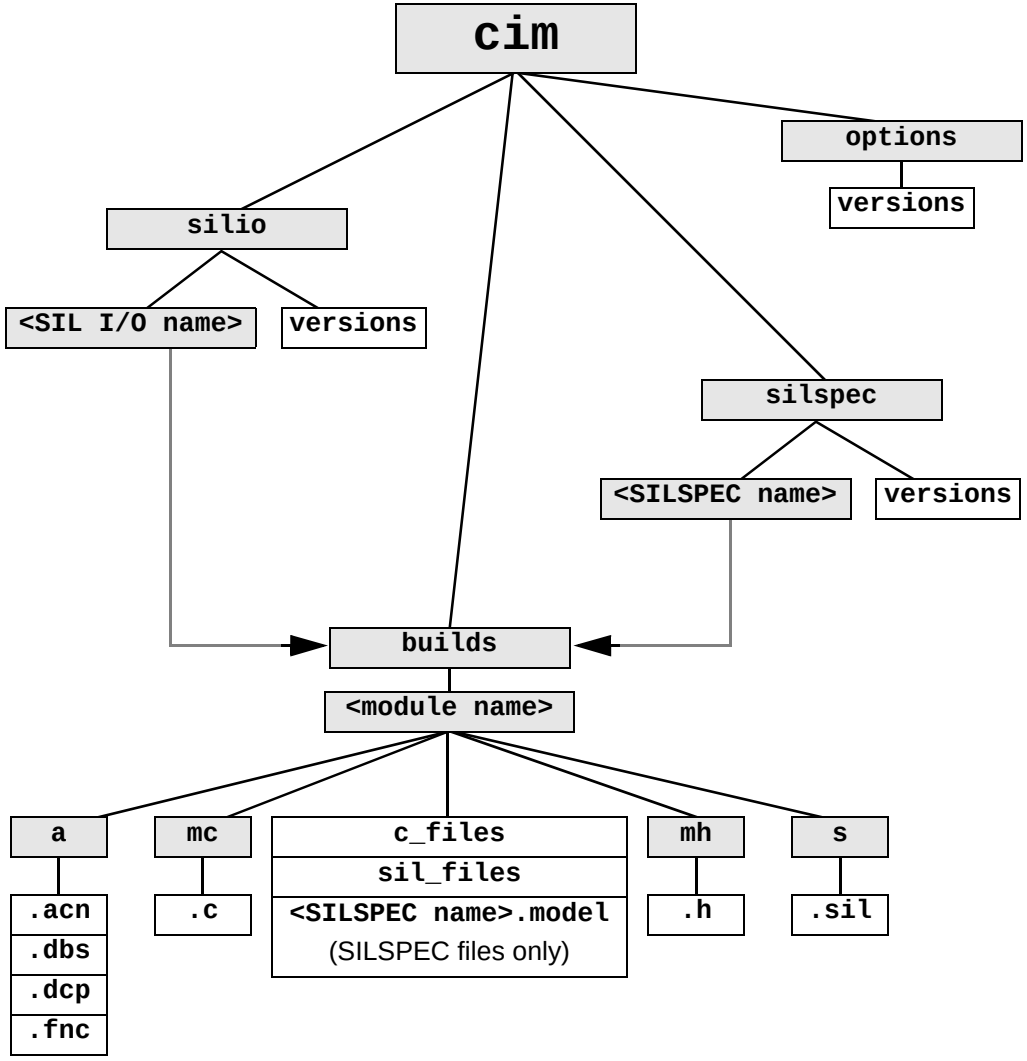


Figure F-3 Standard modules

The `silio` Subdirectory

The **`silio`** subdirectory contains areas for each **SIL I/O** (robot language post-processor) purchased with the base software. Each area generally contains a **`versions`** file which specifies the version number of the module you wish to use.

The `silspec` Subdirectory

The **`silspec`** subdirectory contains areas for each **SILSPEC** (robot model) purchased with the base software. Each area includes the physical model of the robot and a **`versions`** file which specifies the version number of the module you wish to use.

The `builds` Subdirectory

The **`builds`** subdirectory contains user-written SIL application code which can be compiled (once it is debugged), and linked into the Soft Machines base software.

The `options` Subdirectory

The **`options`** subdirectory contains a **`versions`** file for the **`builds`** area, and contains versions for all modules which are not associated with the **`silspec`** or **`silio`** areas.

Components of User-Written Modules

The main subdirectories in this category are **`actions`**, **`mccode`**, **`mhfiles`**, and **`sil`**.

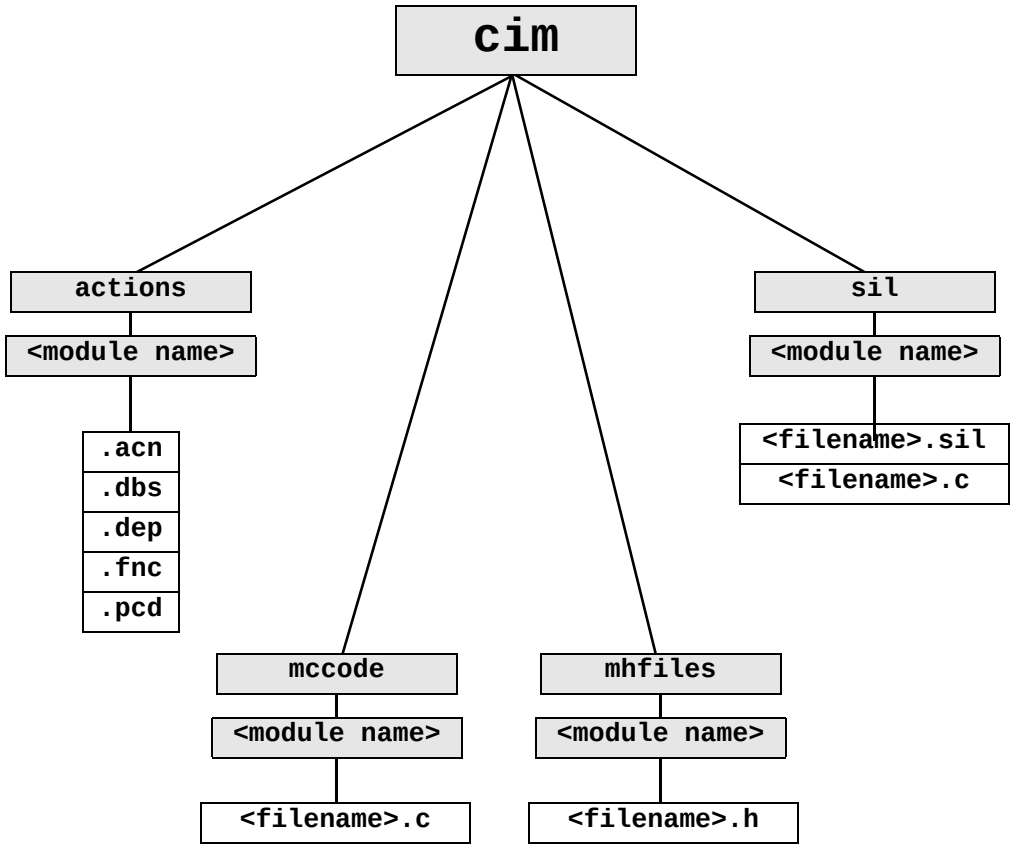


Figure F-4 Components of user-written modules

The `actions` Subdirectory

The **`actions`** subdirectory contains auxiliary information needed for SIL code. The SIL code here is generated automatically by the translator.

The `mccode` Subdirectory

The **`mccode`** subdirectory contains all of the C code whether it was generated with SIL or written by hand. There is one **`mccode`** subdirectory for each module.

The `mhcode` Subdirectory

The **`mhcode`** subdirectory contains the header **`.h`** files for C code generated from SIL. There is one **`mhcode`** subdirectory for each module.

The `sil` Subdirectory

The **`sil`** subdirectory contains all of the SIL code. There is one **`sil`** subdirectory for each code module.

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